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Affairs of the Institute

Annual Meeting Bulletin Board
Food Technology at Summerland, British Columbia
News of the Regional Sections
Personnel
Books
Recently Elected Members
Future Meetings
Selected Abstracts
Food Industry Topics

Annual Meeting Bulletin Board

Food Research Resources in the Ohio Valley. Food research resources in the Ohio Valley Section of the IFT are numerous and varied. It is not possible to cover all the different groups nor all the different segments of food research in one short article; however, the following selected groups represent some of the activities that will be of interest to food technologists while attending the 15th Annual Meeting in Columbus, Ohio, June 12 through 16, 1955.

The Ohio Valley has extensive resources in research and active programs in food science and food technology are being vigorously progressed at its State University, its Agricultural Experiment Station, and its many private agencies. At the Ohio State University in Columbus, the Institute of Nutrition and Food Technology has as its purpose to promote and organize research in foods and nutrition. In a recent report to the National Research Council, fifty projects in these fields were reported as active here, most of them being conducted by the faculty members within departments but many are organized across departmental and college lines. Food technology, food chemistry, human and animal nutrition, biochemistry, horticulture, microbiology, agronomy, plant physiology, dairy and animal sciences, and chemistry and physics are represented in the program of research projects under way or planned at this University. Maintenance of quality, efficient processing and distribution of food, by-product utilization, along with orderly marketing, are also included on the list of research projects at The Ohio State University and The Ohio Agriculture Experiment Station. Experience in research is a major factor in graduate education, which provides trained sicentists in these fields for the Ohio region and beyond. Funds are annually available through the Graduate School and through grants received for the Institute through the Alumni Fund, as well as from industry, government and the State of Ohio. While on the topic of publicly supported research, mention should be made of the intensive study of nutrition in relation to the requirements of Air Force personnel, conducted at the Aero-Medical Laboratory, Wright-Patterson Air Base, near Dayton, Ohio.

Industry-supported Research. The principal activities of the Monsanto Chemical Company in the food field are centered in Dayton, Ohio, where the food technology laboratory of the Inorganic Chemicals Division and several allied laboratories of the Engineering and Research Division are located. These laboratories, in cooperation with other Divisions in the company, have a coordinated program for developing chemicals and chemical applications for the food industries. From these have emanated many advances in the fields of leavenings agents, chemical preservatives, synthetic flavors, soil conditioners, weed controllers, insecticides, fertilizers, detergents and plastics. Because of Monsanto's position as the world's largest manufacturer of phosphorus, principal interest of the Inorganic Chemicals Division is centered on the judicious use of phosphatic materials in foods. In the food technology laboratories are being developed new uses for phosphates as leaveners, emulsifiers, sequestrants, acidulants, buffers, preservatives, and food supplements. Monsanto has demonstrated its interest in the Institute by sponsoring an annual award for the best presentation of a paper delivered at an annual meeting of IFT.

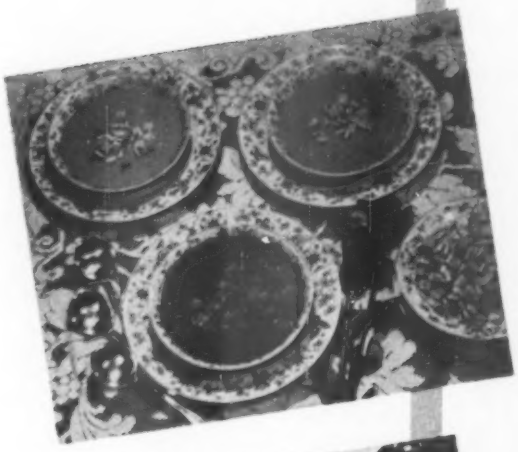
The Kroger Food Foundation is a technical organization serving The Kroger Company, the third largest retail distributor of foods in the United States. The Food Foundation is responsible for the quality of Kroger products and in addition carries out the research and product development required to build high quality in Kroger products and to keep them in step with advancements in Food Technology. A staff of twenty-seven performs these functions, keeping closely attuned to the consumer's desires by utilizing a panel of seven hundred and fifty women, comprising the Homemakers' Reference Committee. Some of the accomplishments for which the Food Foundation has gained recognition include work in the field of Baking Technology, its part in the development of the Tenderay process for the accelerated tenderization of beef, contributions to prepackaging of meats and its activities in the area of consumer preference testing.

The Procter & Gamble Company has its headquarters in the Ohio Valley Section's geographical area. Fats and oils are an important part of its business which also involves soaps, synthetic detergents, and related products. Basic research for Procter & Gamble is done at their new Miami Valley Laboratories in Venice, Ohio. The product development work is centered chiefly at the M. A. & F. Building at Ivorydale in Cincinnati. P & G research work on edible fats and oils includes several continuing basic programs. Other functions of the technical group are (1) to develop products which best meet the needs of its customers, and (2) to help consumers use Procter & Gamble products to the best advantage. Among the consumers of fats and oils in bulk are bakeries, margarine manufacturers, potato chip manufacturers, peanut butter manufacturers, and prepared mix manufacturers.

The Research Department of the Shellmar-Betner Flexible Packaging Division of Continental Can Company is located at the Mount Vernon, Ohio Plant. This Research Department is divided into three groups of activity:

(a) Mechanical Development—Service and Development of Flexible Packaging equipment.

(Continued on page 8)



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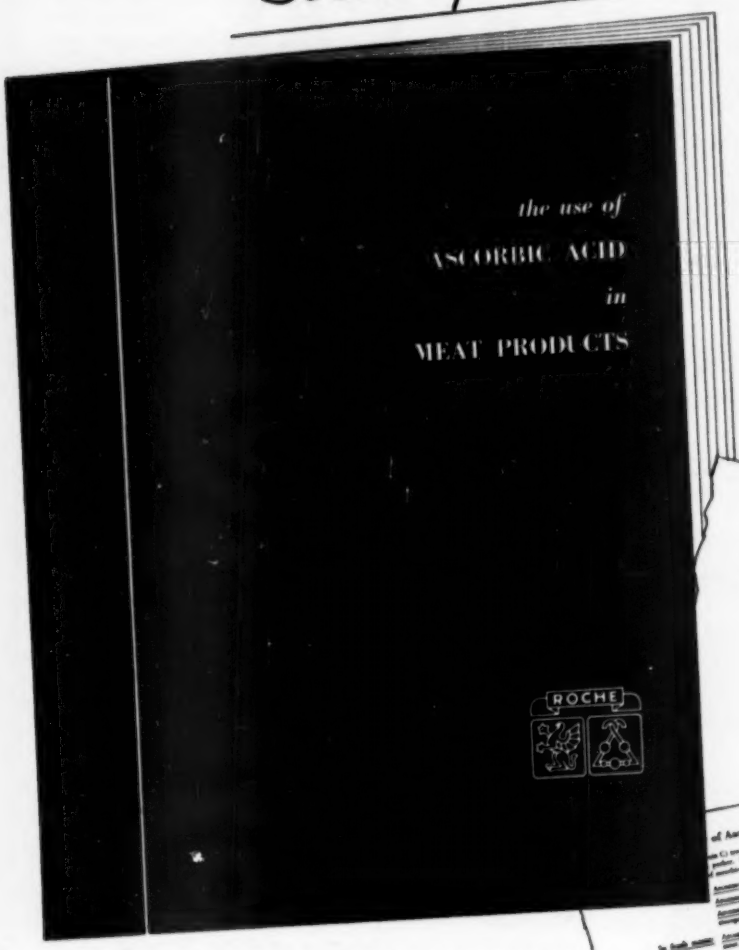

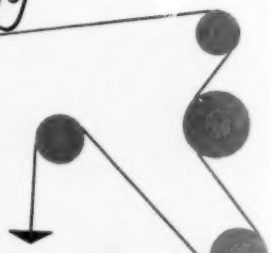

The Roche brochure on the use of ascorbic acid and sodium ascorbate in meat products per B. A. I. memo. # 194

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What About Sodium Ascorbate as Compared to Ascorbic Acid?

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ANNUAL MEETING BULLETIN BOARD

(Continued from page 2)

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(c) Product Methods and Materials Research—Applied research on development and application of flexible packages to packaged items.

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The above five areas of food research resources should serve to demonstrate the diversity of activities as found in the Ohio Valley. In a subsequent issue, later in the year, other research resources of the Ohio Valley will be indicated. For all Food Technologists, especially for the "oncoming generation" of young careerists, the opportunity to learn at first hand the technical interests and objectives of food science in this great area of Mid-America is one that should not be missed.

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NOVEMBER 15, 1954, FINAL DATE FOR SUBMITTING TITLES OF 1955 ANNUAL MEETING PAPERS

The title and a 100-word statement concerning the nature of the paper proposed for presentation at the 1955 annual meeting must be in the hands of F. E. Deatherage, Dept. of Agricultural Biochemistry, The Ohio State University, Columbus 10, Ohio, by November 15, 1954.

Bronze Plaque for Winner of 1955 Best-Process Award Competition to Be Presented at Columbus Meeting

Entries in the competition for the 1955 Food Engineering Award—for outstanding achievement in food processing—may be submitted now.

The deadline is January 15, but it is advisable to send in entries well ahead of that date. Then there will be time to supply more information if additional facts are needed.

Nomination of a novel or improved food process for the Award may be made by anyone. And information by which the Award Jury can evaluate the process will be submitted by those entering the competition.

Information about the process, should be sent to the Editor of *Food Engineering*, 300 W. 42nd St., New York, 36, N. Y. The Editor, who serves as a non-voting secretary to the Award Jury, will pass the information along to the Jurors. One copy of the information is required for each member of the Jury and one for the files, a total of 16 copies. Mimeographed sheets, with photostats of illustrations, are adequate. "Fancy" presentations are not necessary.

The Award Jury is appointed by the Institute of Food Technologists, and its members are leading food technologists connected with colleges and universities.

The best information to submit is a technical description of the process, accompanied by a flow diagram, and pertinent photographs and charts. Explanations of the following should be included:

1. How the process came to be developed, what food company first put it into successful commercial operation, and on what date.

2. The steps by which the process was developed, and what agencies or companies were involved.

3. The success, both technical and economic, which it has achieved.

4. An evaluation of its significance in food processing now and in the years ahead.

This Award is for an improved or novel process, not for a food product itself. And the Award will be presented to a food company, not to an individual person or to an equipment manufacturer. Its purpose is to encourage food processors to develop or to adopt new and better processes.

The process must be in commercial use prior to January 1, 1955, and shall have been put to such use subsequent to January 1, 1950.

The Award, which constitutes a large bronze plaque, will be presented at the next annual meeting of the Institute of Food Technologists in Columbus, Ohio, June 12-16, 1955.

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M. B. DAVIS [a]
A. I. Review

F. E. ATKINSON [b]
A. I. Review

Pilot plant, Fruit and Vegetable Processing Laboratory. Inset: Taste panel evaluating pies made from various pie fillings. Left to right: Mrs. R. Hermiston, F. E. Atkinson, C. C. Strachan, Dorothy Britton.
—Agricultural Institute Review

Quarter Century of Service

Food Technology at Summerland, British Columbia

C. HAMILTON KENNEY [c]
Information Service, Department of Agriculture, Ottawa, Canada

The Canada Department of Agriculture's Fruit and Vegetable Processing Laboratory on the Experimental Station at Summerland, B. C., recently celebrated its 25th Anniversary. During the years, its food technologists have studied a variety of products and their findings have been well adapted by the fruit and vegetable processing industries of Canada and other countries.

In 1929, when the Summerland Fruit and Vegetable Processing Laboratory was organized, 27 establishments in British Columbia manufactured fruit and vegetable products to a value of $5,562,664.00. By 1953, seventy-two plants were in operation and the value of products had increased to $28,479,787.00. At the outset, it should be mentioned that the Laboratory makes no claim for this increase, yet it is significant to note that it has been associated with many important developments. Amongst the projects in which the Laboratory has played an important part in British Columbia have been the development of the apple juice canning industry, the cherry brining industry, and the glacé fruits industry. In addition, the establishment of several single-line canneries, the improvement of dehydrated apples, and the more recent improvement in fruit pie fillings are technological activities which have benefited the Province's agriculture.

Appie Juice

F. E. Atkinson, Laboratory Head, recalls how twenty years ago sweet apple juice contained a heavy sediment; how later they successfully adapted a clarification method from Europe's wine industry employing tannin and gelatin, together with a pectin splitting enzyme process developed by Dr. Z. I. Kertesz [d] of the New York Experiment Station at Geneva, New York; and how the American Can Company developed a new L-type resistant plate which provided a container that would "hold" the juice. But the pasteurization method of that day was too slow. To solve the problem, the Summerland Fruit and Vegetable Processing Laboratory developed a juice sterilizer using the "flash heat" principle which was built in various capacities up to 400 gallons per hour. First operations were small but quality was good and gradually the industry grew until in 1953 the pack of apple juice in British Columbia had a gross value of $1,890,000.00.

[a] Chief, Horticulture Division, Experimental Farms Service, Ottawa, to whom Summerland Laboratory reports. Mr. Davis is a Charter IFT Member.

[b] Officer-in-Charge, Summerland Fruit and Vegetable Processing Laboratory since its inception 25 years ago. Mr. Atkinson is a Charter IFT Member and a former Councilor of the British Columbia Section, IFT.

[c] Associate Editor, *Food Technology*.

[d] Consulting Editor, *Food Technology*.

(Continued on page 12)

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Food Technology at Summerland, British Columbia

(Continued from page 10)

Concurrently with the establishment of apple juice as a commercial canned product, Dr. C. C. Strachan,* the Laboratory's Senior Food Technologist, was conducting research on factors affecting the addition and retention of ascorbic acid in apple juice. This fundamental work on the fortification along with the original efforts of H. C. Aitken, former Departmental technologist now with Kent Foods, Ltd., Canning, Nova Scotia, and also an IFT member, was used by both Canada and the United States in packing apple juice during the last war. The Laboratory has also successfully adapted a process for unclarified juice, in cooperation with R. P. Walrod, British Columbia Fruit Processors Ltd. Today "opalescent" apple juice accounts for about 40% of the Province's production of apple juice. Opalescent in color, this juice is always fortified with vitamin C and retains to a high degree the fresh flavor of the apples from which it is made.

Cherries in SO_2

Would it be possible to economically process British Columbia white cherries in sulphur dioxide rather than import the finished product from Italy? Low prices in the early '30's had B. C. cherry growers considering that their trees be cut. Consulted, the Fruit and Vegetable Processing Laboratory adapted to British Columbia conditions a process using sulphur dioxide with various calcium compounds for hardening used in the Pacific Coast States. To lower the cost of expensive compressed sulphur dioxide, the Laboratory designed and built a sulphurous acid generator in which crude sulphur could be burned and sulphurous acid of between 1 and 1.5 strength obtained. This apparatus reduced the cost of sulphurous acid by 90% and was of considerable assistance in getting the processed cherry industry started.

Fruit Candying

As a "follow through" on the work with cherries in SO_2, the Laboratory went on to the syrup treatment of fruits in the candying operation. After several years' work, they developed a new process that is used in most of the plants in Canada and in several other countries. Chiefly, the process involves: (1) syrup and fruit are maintained at around 140° F. throughout the candying process and, (2) each day the syrup is circulated over an evaporator and concentrated 1% for 8 hours. Maintaining the high heat speeds the process and mechanical handling in large quantities materially reduces the cost.

Dehydrated Apples

Twenty-five years ago the color of dehydrated apples was usually a nut brown soon after the product had been manufactured. The Laboratory found that it was more practical to sulphur the apples in the slice in order to get a better penetration of sulphur dioxide. Further it was found that 90% of the gas originally in the apples was lost during the drying process. Tests with various concentrations of sulphur dioxide showed that a minimum of 750 parts per million would keep the apples in a creamy white state. This finally became a requirement of the Canadian Meat and Canned Foods Act.

Canned Fruit Pie Fillings

It was the contention of the Laboratory's technologists that the sale of canned ready-to-use fruit pie fillings (while not a new product) could be greatly increased if a suitable quality was available to the consumer. The type of filling being tested by the Summerland Laboratory contains up to 80% fruit, about 20% sugar and only sufficient thickener to prevent running (0.2 to 3.0%). Pilot packs of apricot, peach, prune and apple are receiving public acclaim.

Jams and Frozen Foods

The Laboratory is manufacturing jam from district tree fruits and berries, using a variety of conditions. Information being obtained will be of value to the large manufacturer for use in controlling the quality of his jam, and to the small operator who may consider the addition of a jam department to a cannery in order to lengthen the operating season.

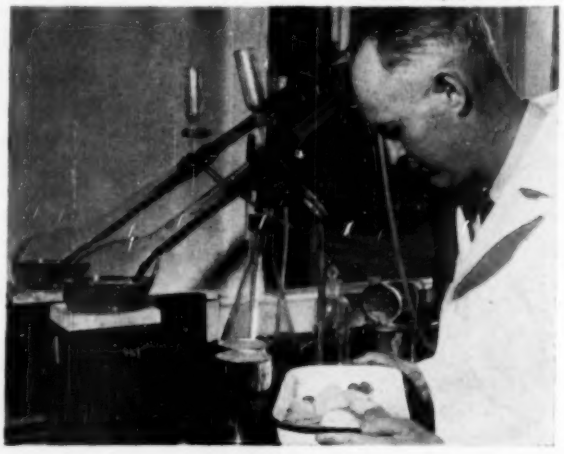
Regarding frozen foods, the full list of vegetables grown in British Columbia has been investigated for freezing qualities, blanching times have been determined, and a study has been made of the retention of nutritive value of frozen fruits and vegetables.

Tomato Juice

Tomato juice research at Summerland has centered around the retention of as much ascorbic acid in the juice as possible. Experiments indicated that a satisfactory process consisted of preheating the prepared tomatoes at 190° F. before milling, filling at 190-195° F., immediately followed by a 10-minute cook for 20 oz. cans at 210° F. With this process under B. C. conditions, the maximum loss of ascorbic acid was 3 mg. and sometimes was as low as 1 mg. Refinements have since been made in blanching the whole tomatoes instead

(Continued on page 14)

C. C. Strachan, Senior Food Technologist, examining a sample of salad pack fruits in connection with can corrosion and fruit discoloration. *—Canada Agriculture Photo*



* Charter IFT Member; former Councilor, British Columbia Section, IFT.

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Monsanto PY-RAN (MCP Anhydrous) . . . for stability never before possible in self-rising flour and cake mixes. PY-RAN gives a slow, controlled gas release during first two minutes of the mixing of the dough or batter. Tests clearly prove PY-RAN releases CO_2 slowly during first two minutes of the mixing of the dough or batter. This two-minute reading is especially important, as any CO_2 evolved during this time will be unavailable for leavening action in the oven.

For more information or a copy of the new booklet, "Monsanto Phosphate Leavening Agents," write to MONSANTO CHEMICAL COMPANY, Inorganic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

PY-RAN: *Reg. U. S. Pat. Off.*

SERVING INDUSTRY...WHICH SERVES MANKIND

Food Technology at Summerland, British Columbia

(Continued from page 12)

of a hot break which heated to 190° F. and a high temperature short time treatment has been substituted for a cook in the container. The process developed by the Laboratory is essentially that employed by most of the canning plants in British Columbia.

Small Cannery Equipment

As a result of helping the small operator by devising equipment for small canneries, many efficient single-line small canneries have been established with several growing into large factories. Some continue to operate as single-line plants, while a few have discontinued operations.

Equipment developed by the Laboratory includes a sulphur dioxide absorption tower which reduced the cost of SO_2 to 10% of that of compressed gas, while devices in the nature of evaporators, insulated tanks, heat exchangers, etc., made possible a hot continuous process for candying fruit. Draper belt cookers designed for small factories are now largely used in the fruit canning industry of British Columbia, and a pilot plant concentrator, evaporator, sterilizer, and filler have proved highly successful in the B. C. Fruit Processors Ltd. plant at Kelowna. Thus the Laboratory is carrying out its policy of building pilot plant equipment and testing it before suggesting the idea to industry.

Conclusion

For space reasons, it is impossible to discuss many other interesting items, past and present, pertaining to the Laboratory's 25 years of service. Readers wishing more information might write to the Laboratory for such publications as "Juice Production" and "Small Canneries." Bulletins in preparation include "Preparation of Candied Fruit and Related Products," "Jam Manufacture," while "Business Problems of the Small Cannery" is currently in press.

IFT MEMBERS AT SUMMERLAND LAB

F. E. Atkinson, B.Sc.	Officer-in-Charge
C. C. Strachan, Ph.D.	Senior Food Technologist
A.W. Moyls, B.S.A.	Junior Food Technologist
*J. F. Bowen, M.S.A.	Bacteriologist
J. A. Kitson, M.Sc.	Chemist
J. A. Ruck, M.Sc.	Chemist
*E. Smith, B.S.A.	Technician (Bacteriology)

*Prospective Member.

Regional Section News

PHILADELPHIA SECTION

The first meeting of the year was held at the Faculty Club of Drexel Institute on Tuesday, October 5, 1954. After an excellent dinner, a movie "A is for Atom" was shown—an animated sound movie in color giving in simple language the story of the atom.

Mr. A. F. Borer, Director of Bakery Mix Laboratories, Pillsbury Mills, Springfield, Illinois, then spoke on "Mixes for the Baking Industry." Mr. Borer, a graduate of St. John's University, has been associated with the industry since the beginning of his career. Mr. Borer related the history of prepared mixes, method of production, technical problems, and analytical methods for determining compositions.

Announcement. The IFT is organized primarily to help technologists in the Food Industry in their work. We meet regularly to augment our knowledge as well as enjoy the fellowship of friends who have similar interests. The Section, as a whole, represents an enormous amount of accumulated knowledge, skill and experience, much of which could and should be made available to those who need it.

Hence, we propose to try a question and answer period—a kind of clinical period—for some of our meetings, whereby opportunity is given to those who have questions on research, quality control, personnel, safety, costs, production, engineering and sales to ask them, with the hope of receiving help from others who have the answers. This is not asking anyone to betray confidential information of their employees for the benefit of competitors, but merely to give of their general experience in solving analogous problems. We propose to bring up a limited number of these questions at a future meeting and, if the response is satisfactory, to continue this as a regular feature.

AUSTRALIA NORTHERN SECTION

Annual Report, 1953-54. Further progress has been made by the Australia Northern Section during the past twelve months. Membership has now increased to over ninety, and we anticipate reaching the hundred mark before long.

Activities for the year included 5 general meetings with Buffet dinners and a Christmas party. The Section was also host at the Fourth Annual Convention of the Australian Sections which was successfully staged at Leura in May. Attendance at the meetings has been good. Members appear to appreciate the excellent food that is supplied at the Buffets, and the opportunity for mixing that the dinner meetings provide.

The Section's Newsletter—"Tucker Box"—continues to be published at regular intervals, and is mailed to all Regional Sections of the Institute. In return we receive the publications of the various overseas Sections and are kept up-to-date on the world-wide activities of the Organization.

The financial position of the Section as outlined in the prepared statement from our Treasurer is good. In addition to our regular funds, there is an additional "Convention Fund" which consists of accumulated profits from our Annual Conventions. Ways of best utilizing this fund are the subject of discussions between the Northern and Southern Sections, and a Committee was appointed at the Leura Convention to make recommendations on the matter.

A directory of members of the Section has been prepared, and is being circulated with the eighth issue of "Tucker Box." It is anticipated that this will be of considerable interest to all.

(Continued on page 16)

THIS KARTRIDG-PAK LINKING MACHINE, together with its accessory equipment, is sanitary, easy-to-clean Stainless Steel. Oscar Mayer & Co. was instrumental in developing this machine, now manufactured by the Kartridg-Pak Machine Co., Chicago.

THIS SPOTLESS BACON LINE at Oscar Mayer & Co., Chicago, makes liberal use of Stainless Steel. The high-speed slicing machine, bacon line stations, conveyor, rollers and other components — all Stainless — were obtained from the Allbright Nell Co., Chicago. Stainless Steel scales are by Exact Weight Scale Co., Columbus, Ohio.

For highest standards of sanitation

Oscar Mayer

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Oscar Mayer & Co., in its 71 years of growth from a small Chicago retail meat market to a nationwide meat processing organization, has constantly sought modern methods and modern equipment. That's why Stainless Steel has played such an important role in their operations.

One of the Company's major developments was the Kartridg-Pak Linker for wiener production. This linker receives a 55-foot length of stuffed cellulose casing, marks off predetermined link lengths, and twists the casing to form links. The linker has maintained production of more than 50,000 pounds for a 40-hour week. It is of Stainless Steel construction.

Like all other processing equipment in the Oscar Mayer plants, this machine is washed down daily and then scrubbed with soap and brushes and disinfected at night. Continual washing and scrubbing, to say nothing of salt in the meat, would cause a corrosion problem if it were not for Stainless Steel.

Other important applications of Stainless Steel in the plants include smoke sticks, work tables, bacon slicing machines, conveyors, rollers, scales, cook kettles, and many more. In every case, Stainless Steel has earned its place by doing a better job of maintaining top standards of cleanliness, sanitation and good appearance. It doesn't discolor, chip, or peel, and it withstands salt corrosion.

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UNITED STATES STEEL

REGIONAL SECTION NEWS

(Continued from page 14)

The Section wishes to express its appreciation to the C. S. I. R. O. Division of Food Preservation for the facilities it so willingly places at our disposal, and to W. H. Brookhouse Pty. Ltd. for undertaking the production and mailing of "Tucker Box."

We look forward to the continued growth of the Institute in Australia, and to continued active support and co-operation of the Regional Section members.

TEXAS SECTION

A meeting of the Texas Section of the IFT was held September 9, 1954. The meeting consisted of a tour through the Maxwell House Coffee and Minute Rice Plants of the General Foods Corporation and through the olive and maraschino cherry packing plant of the Belle Products Company. This was followed by a dinner meeting at the Ben Milam Hotel in Houston.

WESTERN NEW YORK SECTION

The Niagara Frontier Division of this Section held its first fall dinner meeting on September 20 at the Hotel Markeen, Buffalo, N. Y. Charles H. Milton, Vice-President, Firmenich, Inc., was the guest speaker and spoke about some of the recent advances in providing Imitation Flavors and discussed the merits and uses of Imitation Flavors in general.

MARYLAND SECTION

Thirty-three members and guests were present at the September Meeting of the Maryland Section, which was held at the Stafford Hotel, Baltimore, on Friday, September 10, 1954.

The Section was honored in having for its speaker, the nationally-known consultant on pickling problems, Dr. F. W. Fabian, Professor Emeritus of Michigan State College, who addressed the group on the subject of "The Scientific Aspects of Pickling."

Dr. Fabian reported on a recent consumer survey concerning pickles. He stated that flavor and crispness are the two quality factors which largely sell pickles. Housewives in purchasing pickles are influenced by the following factors in the order listed: Quality, Appearance, Brand, and Price. Eight out of ten housewives prefer pickles in glass and would rather buy a small jar than a large jar. Preferences for types or styles of pickles are: 1. Small Gherkin, 2. Kosher Dill, 3. Regular Dill, and 4. Sweet Mixed or Relish.

In 1930, 3 to 4 million bushels of cucumbers were used for pickles. In 1954, it is anticipated that 11 to 12 million bushels will be used in the processing of pickles. At present, pickles are the third largest food canned. They follow peas and corn, and immediately precede tomatoes.

There are two principal methods of preserving pickles: 1. Salting and 2. Pasteurization (so-called fresh pack.) Over one-third of all pickles being sold are preserved by the fresh-pack method.

Salting draws out the water and the nutrients from cucumbers and controls microbial action. Only a few bacteria can live in a salt solution which is in excess of 7½%. Only a few yeasts can live in a salt solution which is in excess of 15%. There are three types of fermentation in salting:

1. *Normal*—Lactic Acid Type.
2. *Yeast Type*—Stormy, does not produce acid, only gas.
3. *Aerobacter Type*—Only produces gas.

The lactic acid type of fermentation is the only desirable type because salt plus lactic acid preserves the pickles.

Spoilage of salt stock is generally due to pectic enzymes, particularly pectin esterase. A pickle is essentially held together by pectins and when wild microflora produce pectic enzymes which attack pectins, then the pickles become soft and collapse. The first two or three days of salting is a critical period and one in which unwanted organisms can develop.

After salting has been completed and the pickles are ready to be packed, they must be desalted. A good rule of thumb to follow is the shorter the desalting time, the better the finished product and the least trouble with spoilage. Desalting should take from 8 to 24 hours.

Lastly, the desalted pickles are ready for finishing. Sweet pickles are prepared by adding acid, salt, and sugar to the containers. There must be at least 2% acetic acid present or else pasteurization will be necessary. Finally the pickles are spiced. Almost all of the packers have changed from using whole spices to essential oils.

A lively discussion followed Dr. Fabian's presentation, and there were many comments that this meeting had been the most interesting one of those held during the present series.

DR. H. J. DEUEL, JR. ANNOUNCED AS WINNER OF MONSANTO AWARD

The Monsanto Award Committee has announced the winner of the 1954 prize to be: Dr. H. J. Deuel, Jr., Dean of the Graduate School, University of Southern California, Los Angeles. It was the excellent presentation and the quality of Dr. Deuel's paper "Newer Concepts of the Role of Fats and the Essential Fatty Acids in the Diet" that brought the award. Forty-nine members of IFT served as judges, attending one, and in some instances as many as four sessions of the Los Angeles program to evaluate the presentation of nearly 180 technical papers.

Close on the heels of Dr. Deuel and rating honorable mention by the 49 judges were T. H. Schultz, who spoke on the incorporation of natural fruit flavors into fruit powders, William F. Talburt, whose paper was devoted to dehydro frćezing, and Wendell Griffith who reported on newer concepts of optimum nutrition. Betty Watts, F. N. Peters, J. B. Moster, Z. I. Kertesz, E. C. Clement, R. L. Cheney, and A. A. Klose were additional winners of honorable mention. The speakers were rated on eight elements—voice, diction, poise, use of manuscript, quality of slides, plan of illustrative material, apparent audience interest, and gauging of time limit. The Monsanto Award is receiving increasing attention each year as a friendly competition designed to furnish

(Continued on page 18)

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REGIONAL SECTION NEWS

(Continued from page 16)

an incentive to speakers to project their data and conclusions out to their listeners with maximum effectiveness. The closeness of this year's contest indicates that more and more authors of technical papers are becoming cognizant of their responsibilities to an audience. In addition to the speakers mentioned the score cards of the judges showed numerous others to be in the running.

PERSONNEL

Miss Sally Foss has joined the research staff of Henningsen, Inc., of Springfield, Mo., where she will be engaged in developmental work on new and improved egg products. Miss Foss holds a bachelor's degree from Hood College in Maryland and her M.S. from Iowa State College at Ames, where she studied under Dr. Frances Carlin.

Dr. James C. Moyer, Associate Professor at Cornell University and a member of the staff of the Agricultural Experiment Station, Geneva, New York, has been awarded a Fulbright Grant and has accepted appointment as visiting lecturer in food technology at the New South Wales University of Technology, Kensington, N. S. W. Accompanied by Mrs. Moyer he will proceed to Australia via England and the Continent, arriving at Sydney, where he will be stationed, in December. Working with Dr. F. H. Reuter, who heads up the recently established Department of Food Technology at the host institution, he will conduct research work in the area of fruit and vegetable processing. Field trips into the growing and processing areas will be the first order of business for Dr. Moyer.

In Memoriam

It is with sorrow that we report the death of Carl W. Nordgren, 54, corresponding secretary of the Mohawk Valley Section of the Institute of Food Technologists. He died suddenly at his home on September 3, 1954, of a heart attack. At the time of his death Mr. Nordgren was Laboratory Director of Chr. Hansen's Laboratory at Little Falls, New York. He was a member of the Senior Advisory Board at Hansen's, an executive group composed of department heads, and was responsible for quality control, research and new product development. All who had worked with him and observed him in his labors were impressed with his tenacity and determination to accomplish those goals for which he set out, whether they were in personal or business matters. Mr. Nordgren was graduated from Cornell University in 1921 and in addition to a bachelor's degree also held a master's degree from that Institution. He leaves his wife, one daughter, and two sisters.

Mr. Mark J. Ingle, 70, Chief Chemist for Richardson Corporation, died on August 21 after a short illness. Mr. Ingle was with Richardson Corporation for 28 years. He was a member of the American Chemical Society and a charter member of the Institute of Food Technologists. He is survived by his wife Dorothy and two sons Barr and James.

1954 Fellowship Awards

Florasynth Fellowship Award for 1954 Won By John E. Schade, University of California

Dr. P. K. Bates, President, Institute of Food Technologists, announces that the IFT Committee on Awards has selected Mr. John E. Schade, a student at the University of California at Davis to be the 1954 winner of the **Florasynth Fellowship Award.** Professor Emil Mrak, head of the Food Technology department at the University, has notified Mr. Schade of his election to receive the Award, and he will be presented with the coveted distinction at a forthcoming meeting of the Northern California Section. The 1954 contest closed on August 1, 1954 and between that time and the decision, October 4, 1954, the Awards Committee has been busy going over the qualifications of the various nominees—a difficult task in view of the excellent talents and attainments of the 1954 group of candidates. The honorarium that goes with the award is five hundred dollars.

Award for 1955 Now Open for Entries

Award for 1955 Now Open for Competition. The **Florasynth Fellowship Award** is given annually to a young man or woman, under 35 years of age, who has outstanding qualities of character and personality and has demonstrated scientific or engineering ability in Food Technology in a recognized college of the U. S. A. or Canada. Candidates must be seniors or graduate students to be eligible for the award. Nomination for the award is made by the head of the department who supervises the work of the candidate.

The 1955 Award nominations (to be made by the head of the department who supervises the work of a candidate) must be received by the Office of the Secretary of the Institute, 176 West Adams St., Chicago, not later than February 1, 1955. After the Awards Committee has come to a decision, the name of the winning candidate will be announced at the annual meeting of the Institute of Food Technologists, June 12-16, in Columbus, Ohio.

Committee on Awards selects Harold R. Rich as 1954 winner of the General Foods Fund, Inc. Fellowship.

The **General Foods Fund, Inc. Fellowship** for 1954, which is the initial award from this fund, goes to Mr. Harold R. Rich, a student at the Massachusetts Institute of Technology, according to an announcement by IFT president, Dr. P. K. Bates. The award is for the full calendar year and furnishes the winning applicant with living expenses at a minimum rate of $200 per month and all academic fees . Total value of a single Fellowship from the General Foods Fund, Inc. is $4000. Dr. B. E. Proctor, head of the Food Technology courses conducted at M. I. T., has notified Mr. Rich of the honor conferred upon him and at the awards session of the annual meeting of IFT in Columbus, Ohio (June 12-16), appropriate ceremonies in recognition of the award will be held.

(Continued on page 20)

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greater sales appeal...
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You get the direct and authentic reproduction of raspberries in their full perfection in Raspberry Flavor by Firmenich. For Firmenich took fully ripe raspberries, freshly severed from the stem, captured their delicate and fugitive flavor, and by original research reconstructed it in all its significant and desirable components. Firmenich Raspberry comes to you as a precise and potent flavor material of the utmost purity and stability to enhance the flavor of your products and to make them more attractive to your customers.

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Churning Extreme care is required when whipping cream to avoid forming butter. But our laboratories have found the inclusion of Myverol monoglycerides to permit up to 10 minutes of beating after full whip with still no indication of churning. Untreated, the same cream churned immediately upon whipping.

Findings like these go on and on, as we delve into the behavior of our unique molecularly distilled *concentrated* monoglycerides in dessert toppings based on evaporated milk, sweetened condensed milk, homogenized cream, light cream, medium cream, and reconstituted dried cream. You can get the facts to date—and more as they come—by writing to ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies and Company, Los Angeles and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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1954 FELLOWSHIP AWARDS

(Continued from page 18)

Rules Governing the Awards

Funds for this Award are provided by the General Foods Fund, Inc., a foundation supported by General Foods to conduct a graduate fellowship program in the field of food science; the program is administered by the Institute of Food Technologists. The fellowships are granted annually, no more than two to the same institution, but will be renewable upon application to and approval by the Awards Committee in order to provide continuity of studies toward the degree of Ph.D. if the winning candidate so plans. The Generals Foods Fund, Inc. is financing this fellowship program by making contributions to the Institute of Food Technologists in the sum of $4000 for Academic Year 1954-55; $8000 for 1955-56; and $12,000 for each year thereafter. It is the intention of the directors of the Fund to continue the program from year to year, but the right is reserved to discontinue support of the fellowship on due notice.

Where and How to Apply

Candidates for the Fellowship are selected by the Committee on Awards (IFT) from a roster of applicants who have submitted applications to the Office of the Secretary of the Institute of Food Technologists, 176 West Adams Street, Chicago, prior to February 1, 1955. Applications must be in letter form and furnish the following information: Name; nationality; sex; age; marital status; physician's statement as to health; educational and experience background; college scholarship record; noteworthy research accomplishments; and the applicant's purpose in applying for the Award. Three letters of recommendation shall be forwarded, separately, to the Secretary's Office (IFT) by deans, heads of departments, and/or professors who have supervised the research work of the applicants. A statement by the head of the department where the work will be done, endorsing the applicant and accepting the responsibility connected with the Fellowship, is also required.

Further details are available in a leaflet which will be supplied on request by the Secretary of the Institute of Food Technologists, 176 West Adams, Chicago, Illinois.

Books

ADVANCES IN ENZYMOLOGY, Volume 15. Edited by F. F. NORD. 547 pages, Interscience Publishers, New York-London, 1954.

This volume of *Advances in Enzymology* contains eleven high quality articles, most of which will have either general or specific interest to food technologists. Most notable with specific interest is the chapter on "Rennin and the Clotting of Milk" in which N. J. Berridge, Shinfield, Reading, England, ably reviews this phase of cheese manufacture. The chapter on "The Mechanism of Enzymic Oxido-reduction" by S. J. Leach, Melbourne, Australia, discusses interestingly and provocatively the "micro-mechanism" of enzymic catalysis as opposed to the gross or over-all changes that occur at various stages of oxido-reduction reactions. Thomas P. Singer and Edna B. Kearney, Madison, Wisconsin,

(Continued on page 22)

Notes from the makers of
Myvax Vitamin A

Vitamin A
in a shrimp's eye

We used to make vitamin A out of fish liver oils. Europe *still* gets much of its vitamin A from Antarctic whales with the help of radar, explosive harpoons, and highly efficient factory ships.

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In 1948 we brought out the first man-made vitamin A available in America in commercial quantities. It started something. The whole American industry turned to synthetic vitamin A.

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We are interested, for example, in the fact that the whales feed interminably on shrimp. Running it back a step, we find that shrimp manufacture vitamin A in their eyes, and in great quantity—as much as 12,000 International Units of vitamin A per gram, dry weight, for large specimens of *Meganyctiphanes norvegica*.

Running it back still another step, the potency of vitamin A oil in these deep sea crustaceans measures two or three times higher chemically than it does biologically. The answer to such an anomaly might some day help all of us obtain better, more versatile synthetics.

So we keep inquiring about it—even though we've left the shrimp and the whale far behind as economical producers of vitamin A.

Vitamin A is a fast-breaking subject. If you use it in your product, it's nice to be able to feel that you won't be caught in the backwash of developments. You enjoy that feeling by keeping in touch with the makers of Myvax Vitamin A and Myvapack Vitamin A—both immediately available from stock so that you can keep your vitamin A inventory at any level you like. ***Distillation Products Industries,*** Rochester 3, N. Y. (Division of Eastman Kodak Company). Sales offices: New York and Chicago • Charles Albert Smith Limited, Montreal and Toronto • W. M. Gillies and Company, Los Angeles and San Francisco.

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BOOKS

(Continued from page 20)

present a valuable review of the "Chemistry, Metabolism, and Scope of Action of the Pyridine Nucleotides Coenzymes" in which the characteristics of over 20 pyridinoprotein enzymes from a variety of sources receive attention. In the chapter on "Alternate Pathways of Glucose and Fructose Metabolism," Efraim Racker critically reviews and integrates where possible the physiological role of the large number of new enzymic reactions encountered in carbohydrate metabolism. Severa Ochoa, New York, in reviewing the "Enzymic Mechanisms in the Citric Acid Cycle" stresses the mechanism of citric acid synthesis. Available evidence and theories of "The Mechanism of Action of Hydrolytic Enzymes" is discussed clearly by H. Lindley, Melbourne, Australia. Maurice Stacey, Birmingham, England, presents an interesting, concise review of the "Enzymic Synthesis of Polysaccharides." A comprehensive review of "Urea Synthesis and Metabolism of Arginine and Citrulline" is given by S. Ratner, New York. A valuable review of "Thiaminase," the thiamin destroying enzyme discovered in 1941, is made by Akiji Fujita, Kyoto, Japan. The review by René Wurmser of the important subject "Thermodynamique des Reactions Immunologiques" may be of somewhat less interest to food technologists than the foregoing chapters. The same is true of the chapter on "Die Struktur Des Tabakmosaik-virus und seiner Mutanten."

While the reviews are written primarily for the specialists, they are quite well presented and the more casual reader as well as the specialist will find much of interest in them.

HANS LINEWEAVER
Albany, California

BREAD. By Lord Horder, Sir Charles Dodds, T. Moran; Constable and Company, Ltd., 10-12 Orange Street, W. C. 2, London, and Longmans, Green and Company, Toronto, Canada (1954). 185 pp. Price—18s. net.

Occasionally one reads a technical book which is delightful. This is such a book.

No attempt has been made to exhaustively cite the literature. Rather, the authors have preferred to write in a more generalized style, citing key references to support their statements. The result is a book full of generalizations and "rule of thumb" type statements that are easily remembered and drawn upon when discussions about bread arise.

The authors have had much to do with the decisions concerning the type of bread that was made in England during World War II and the years following. Thus, they draw upon a fund of practical experience. Lord Horder and T. Moran still serve the Minister of Food in England in addition to other duties, and Sir Charles Dodds is the Courtauld Professor of Biochemistry at the University of London. They present a picture of bread somewhat different than that which is typically American, and for this reason alone, the book should be read by workers in this country.

The book begins a discussion of the history of bread, and the next four chapters deal with the agronomic aspects of growing wheat, the chemistry of wheat, flour and bread, milling and baking, and improving agents. The last chapters are concerned with the food aspects of bread such as the digestion and assimilation of bread, the nutritive values of bread, enrichment programs, and the relationship of bread to diseases such as obesity, caries, rickets, and digestive ailments. There are few errors. Those noticed were such as the misspelling of cited authors' names.

The book is profound and yet simple. It is the type of book which could be given to the student eager to learn about bread but having no particular background in the field. In the words of the authors, "We had in mind mainly that section of the public which possesses a scientific background—a section which includes the doctor, the science teacher, the social worker, and the dietician." It is recommended reading.

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The Inquiring Mind[a]

L. A. DuBRIDGE

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In 1798 a monk by the name of Thomas Robert Malthus published a paper with a long and complex title which attempted to analyze man's future on this planet. Examining past experience and bringing to bear on this experience the brilliant logic of an analytical mind, he came to some rather dire conclusions about the future. It was quite obvious to him that men had to eat; that the only major source of food was the arable land; that the area of such land was limited. Therefore there was a limit to the potential food supply, and hence to the population that could exist on the earth. On the other hand, he noted that the human population tended to grow at an ever-increasing rate. Any sort of population control, it seemed to him, would be either unnatural or immoral. Therefore the only possible future was one in which the population eventually outgrew the food supply, and thereafter death by starvation, disease and war would take over to balance a birth rate which knew no control. Clearly, a world in which most of the people would assuredly die of one of these causes was not a very pleasant one to contemplate.

However, here we are 156 years after the Malthusian prediction, and the portion of the world that we live in does not face the Malthusian death sentence. Our population is expanding at a rate never dreamed of in Malthus' time. There are four times as many people on the earth now as then. At the same time, here in the United States at least, we have far more trouble with food surplus than with shortage. We buy potatoes and dye them blue, butter and let it spoil, wheat and give it away, in our desperate effort to avoid the economic consequences of growing more food than we can eat.

Surely Malthus was the most mistaken man in history. Or was he?

Actually, as Harrison Brown points out in his recent book (from which I shall now borrow heavily), "The Challenge of Man's Future," Malthus' reasoning and logic were entirely correct. His only misfortune was that his observations and assumptions were later rendered obsolete by unforeseeable new developments. What were these new developments? They were of two kinds —technological and social. On the technological side men learned how to raise more pounds of food to the acre, learned to get more nutritive value to the pound, and learned how to transport food quickly from areas of surplus to areas of shortage. On the social side great segments of the human race came to regard population control not as a sin but as a virtue.

Now I think it is quite evident that without this latter factor—voluntary population control—the Malthusian disaster can be only postponed and not finally prevented by any advances in technology. We must admit that the supply of land is limited, that the productivity of land can *not* be expanded beyond all limit. But population, if not controlled, does expand without limit and sooner or later—in 50, 250, 500 or 5000 years—a population which is doubling every 75 years or so is bound to outrun any given food supply.

This makes it clear that the primary need of the world is to insure that in all parts of it the population recognizes the need for growth that is controlled by voluntary action rather than through starvation. Clearly this is not primarily a job for science and technology, but rather for education.

But science and technology do have some terribly important tasks to perform in this field. First, there is the task of improving the technology of producing, processing and preserving food so that the food supply will keep pace with population for the 25, 50 or 100 years required to complete the educational job. Second, there is the task of improving standards of living over a larger part of the world—for increased education goes only with increased living standards and increased disposable wealth. Finally, science and technology have the task of providing the necessary tools so that any segment of the population that has overcome the starvation limit can then proceed to help men and women lead happier and richer lives.

Now I claim that these constitute quite substantial and immensely challenging tasks. Another way of expressing them is to say simply that if men are to attain those social, moral and spiritual goals which we of the Christian nations believe desirable, then science and technology must provide the physical tools to make their attainment feasible.

This being about as important a goal as I can think of, it behooves those of us who are working in the fields of science and technology to ask ourselves how we are doing. Have we properly visualized our task and our goals? Have we properly analyzed and evaluated the steps which need to be taken, the prerequisites for progress? Are we putting first things first and do we know which things *are* first? Are we creating within science and technology itself and within the community at large, the conditions most likely to nurture progress and success?

Now it would be presumptuous of me to attempt to answer these questions or to try to solve the problems they suggest. But I can presume to raise the questions and ask you to think about them, in the hope that if enough people think about them, we may some day get them answered.

OUR GOAL IS A MORAL GOAL

It seems to me obvious from the way in which I have stated the problem that it is important that we keep in mind the goals we seek. As I have suggested, these goals are not merely more food, more products, more gadgets. Our goal in the last analysis is a moral goal—more happiness for individual human beings, expressed in whatever terms their own philosophy of life dictates. Now I emphasize and repeat this matter of ultimate

[a] Delivered at opening session, June 28, 1954, 14th Annual Meeting, Institute of Food Technologists, Biltmore Hotel, Los Angeles, Calif.

goals precisely because it is so obvious to us that it is often forgotten. We become so absorbed in our gadgets, our machines, our new foods, new medicines, our new weapons, that only too often we think of them as ends in themselves—forgetting what they are *for*.

Now if we ourselves—if we scientists—forget the ends in our absorption with the means, that is bad enough; for then our work loses its meaning.

But it is even more dangerous if we let the public believe that our machines and our mechanisms are ends in themselves. For then our work, which in the end depends upon public support, will surely be destroyed. And it will be destroyed by the public even though the public itself, rather than the scientists, would be the principal losers.

Let us bring this closer home. It is a paradoxical fact that in these days of mid-twentieth century, science and technology are being simultaneously praised to the skies and damned with religious fervor; they are being handsomely supported and heartily kicked. Scientists are publicly acclaimed as a group and privately slugged as individuals.

Why is this?

Clearly, we have not told our story adequately. Our physical achievements are evident. But, because they are physical, we are accused of being materialists. Because the tools of science are powerful, their power is feared and those with the power are suspected of evil motives. Because weapons have been produced to help men fight in their own defense, it is assumed that they also make men *want* to fight. So we see that as we brag about our knowledge but are silent about our aims, then the public will come to ignore our knowledge and denounce our aims.

So my first plea is that scientists shall throw off their reticence in speaking of their feelings and come out boldly and unashamedly to say, "We are working for the betterment and happiness of human beings—nothing less and nothing more."

But, in spite of the romanticism of the poet, we know full well that for most human beings happiness is not attained solely by sitting under a tree with a loaf of bread and a jug of wine. And even if it were, someone has to bake the bread and bottle the wine. The poet was right in suggesting that the essential elements of happiness consist of food, shelter, companionship and leisure. He only forgot to mention that these must be achieved by effort, and that the effort itself may bring happiness too.

In any case, we are forced at once to consider how human effort can be most effectively employed to provide the physical elements for happiness and also the leisure to enjoy them. Nor are we content—as were those of the medieval and ancient times—to have *many* people exert the effort and a *few* people enjoy the leisure. We have proved that *all* may work and *all* may play.

Now what is it that has made it possible for us today to think of a modest amount of happiness coupled with a reasonable amount of work as a possible goal for *all* people, rather than for just a few? The answer is, clearly, that a series of *intellectual achievements* have enabled men to enlarge, to expand and to dream of achieving a moral goal.

What are the intellectual achievements?

A NEW PROCESS OF THINKING

It is fair to say that the essential cause of the difference in the physical and the moral outlook of the western world in the 20th century as compared to the 10th is simply that, along some time between those dates, men invented a new process of thinking.

Men had, of course, always thought, always observed, always speculated, always wondered, always asked questions, always explored. But along about 1700 men began to do these things in a new way. Men began to realize that by making observations carefully and analyzing them quantitatively, it could be shown that nature behaved in a regular manner and that these regularities could be discovered, reduced to mathematical form and used to predict future events. This was an astonishing discovery. And as this new concept, outlined by Francis Bacon, was pursued—first, by Galileo, then by Newton, then many others—a new world of understanding was opened to men's minds. Nature was partly comprehensible, not wholly mysterious and capricious. The falling stone and the moving planets became suddenly not only understandable but miraculously and simply related. Men couldn't *affect* the motion of the planets, but they *could* control the motion of the stone and of other objects. And so, machines were invented, the concept of energy emerged, steam was put to work—and suddenly, after thousands of years of doing work only with the muscles of men and animals, men found that a piece of burning wood or coal could take the place of many slaves or horses or oxen.

From that time on, happiness and leisure for all men became a possible goal, not a crazy dream.

But that was only the beginning. The scientific method led from physics to astronomy to chemistry to biology. A beachhead on the shores of ignorance became a vast area of knowledge and understanding. Yet, as the frontiers of knowledge advanced, the area of ignorance also seemed to enlarge. Nature was not simple after all. A literal eternity of new frontiers was opened up. The quest for understanding, we now see, will, for finite man, be limitless.

I need not recount to this audience the way in which this new understanding has spread—often slowly, often with startling rapidity—from one field to another.

But I would like to direct your attention to the conditions that are required for knowledge and understanding to grow and to spread. Intellectual advancement does not come about automatically and without attention. There have been throughout human history only a few places and a few periods in which there have been great advances in knowledge. Only under certain special conditions does the inquiring mind develop and function effectively. Can we identify these condition? Certainly we must try.

The first condition, of course, is that at least a few people must recognize the value of the inquiring mind. Here in this room we all take for granted that new ad-

vances in understanding come only from the acts of creative thinking on the part of individual human beings. We know that, and we respect and admire the men who have shown the ability to think creatively. But we mustn't get the idea that our admiration for original thought is shared by all people. Even in this country, the man who thinks differently is more often despised than admired. If he confines his new thoughts to the realms of abstruse theoretical physics or astronomy, he may not be molested. For then he will be speaking only to those who understand him. But if he wanders into biology or medicine, into psychology or sociology or politics, then he should beware.

Now in recognizing the virtues of thinking differently, we do not mean that we must encourage the idiot, the criminal or the traitor. Honest, truly intellectual inquiry is perfectly easily recognizable by those who have some training in the field. But just here we run into difficulty. Those who are incompetent to judge may nevertheless render judgment and pass sentences on those with whom they disagree, or whom they fear. One of the great unsolved problems of a democracy is how to insure that in intellectual matters judgments are left to those who are competent and the people will respect that competence. But when uneducated fanatics presume to choose and to censor textbooks, when government officials impose tests of political conformity on the scholars that may enter or leave a country, and when the editors of a popular magazine set themselves up to judge who had the proper opinions on matters of nuclear physics, then the inquiring mind finds itself in an atmosphere not exactly conducive to maximum productivity.

Fortunately, for the past 100 years in Western Europe and in the United States the impediments to creative scholarship have been less important than the great encouragements. In the past 10 years the physical conditions necessary for research in the sciences have enormously improved. More opportunities have been created to study, to travel, to carry on research, than ever before existed.

But physical conditions are not enough. Big, beautiful laboratories do not themselves produce research—only the men in them can think. And if conditions are such as not to attract men who think or such as to impede their thinking, then the laboratory is sterile. Such laboratories, as you well know, do exist. There is no use storming and raging at the perverseness of scientists who refuse to work when conditions are not just to their liking. We don't call a rosebush perverse if it fails to bloom when deprived of proper water and soil. A community or a nation which wishes to enjoy the benefits that flow from active inquiring minds needs to recognize that the inquiring mind is a delicate flower, and if we want it to flourish we are only wasting our time if wo do not create those conditions most conducive to flowering. The cost of doing so will be well repaid.

The inquiring mind then needs, first of all, some degree of understanding and sympathy within the community. And if there are those who cannot understand, then at least they must be insulated by those who do, so that they do the least harm. As someone has said, we can stand having a few idiots in each community as long as we don't put them on the school board.

As I have already suggested, it is not enough for the scholar or the scientist to wring his hands and wish that there were fewer idiots or that they had less influence. He must also, to the extent of his ability, explain to those who can understand what he is doing and why. We now see that an intelligent and informed segment of public understanding is essential to the progress of scholarly endeavor.

THE SCIENTIST AND GOVERNMENT

This leads me to another subject which has become timely to the scientist and to the citizen in recent years; that is, the relation of the scientist to government. This is obviously a very large subject which I can not attempt to explore here. But as the scholar needs an informed community to support him, so he owes an obligation to that community.

The prime obligation of the scholar, of course, is to pursue scholarship. That is, he must seek answers to important questions, he must observe carefully, analyze accurately, test rigidly, explain imaginatively, and test and test again. Then he must publish his results, fully, fearlessly, objectively, and defend them enthusiastically unless or until the facts prove him wrong. Through such intellectual struggle does the truth emerge.

But in these days the results of science impinge so heavily on public affairs that the public—in particular the government—needs the scientists' help in many important ways. Obviously, the government needs the direct services of thousands of scientists and engineers to carry on work in public health, standards of measurement, agriculture, conservation of resources and in military weapons, to name a few. But when there is developed a new weapon, a new treatment for a disease, a new way of using public resources, does the scientist's responsibility end there? I think not. There are too many ways in which important matters of public policy are affected by these new scientific achievements, that scientists must stand by as advisers at least to interpret, explain, criticize and suggest on policy matters. We would not think, of course, of allowing a new law affecting public health to be passed without asking a physician's advice on whether it is wisely conceived. We wouldn't think of it! Yet I am sure state and federal legislatures have thought of it—in the various antivivisection bills, for example. Fortunately (for this purpose at least), the medical profession has great influence and can make its opinions heard. And most of the public respects its doctors.

But when national security matters are being discussed which involve the nation's strength in atomic weapons, it is clear that those in charge of forming policy will need to have much help on questions of what atomic weapons really are, what they do individually, and what would be the effects of setting off the whole stock pile. I am not saying that such scientific advice is not sought (though I think it is not always adequately used). But I do say that scientists need to be ready to help. Yes, they may need to be ready to intrude with their advice even if it is not asked for.

This problem has, of course, caused much recent trouble and misunderstanding. Many prominent citizens, including many politicians and many editors,

apparently feel that scientists should stick to the laboratory and let public policy matters be handled by others. Now everyone agrees that *decisions* on public matters must be made by the properly constituted responsible officials. But *advice* and *information* on scientific aspects of the problem are often essential and must come from scientists.

It is often true that the scientific aspects of a problem are so important that they overshadow all else—and the scientist's advice becomes adopted as a decision. But in other cases, other factors may appear important and the scientist's advice may be wrong, or may not be taken. Even the scientist, being human and being a citizen, will take non-scientific matters into account in rendering his advice. He may be just as competent to do this as any one else. Being a scientist does not disqualify a person from being an intelligent citizen. But the possibilities of disagreement and controversy and misunderstanding are very great. A very great and admittedly completely loyal scientist is right now being persecuted partly because, though he gave advice of surpassing value on many, many occasions, he gave on one occasion advice which some (but by no means all, then or now) believe was wrong. The sad part of this case is not so much the harm to the individual, as the harm to the country that will result if scientists can not give honest advice to their government officials, or will no longer be asked for advice, or listened to. Dire disaster could indeed follow from such a course pursued in the thermonuclear age.

You will conclude that I have wandered far from my topic. That is a privilege which a speaker often takes, and I shall not apologize. But you will see that I fervently believe that the world has been remade in the past century — remade physically, socially, and spiritually—by the work of inquiring scholars. These scholars have sought new knowledge and new understanding; they have sought to use this understanding to produce those things that men needed—or thought they needed—to improve their health, their comfort, their happiness, their security. Scholars will continue these activities and the world will continue to change. Their efforts must be aided; for though what they do may yield dangers, the dangers are far greater if they do less. And since what they do affects the world, affects you and me and our community and our country, we should have these inquiring and active minds around all the time to direct their attention to the most difficult of all problems—how to help men make better use, in their relations with each other, of the great new areas of knowledge which can yield so much to make men happier and better.

Newer Concepts of Optimum Nutrition[a]

CHARLES GLEN KING

Scientific Director, The Nutrition Foundation, New York, N. Y.

(Manuscript received July 1, 1954)

The two simplest factors in controlling food intake are reflected in thirst for water and hunger for a source of energy or calories. Though very primitive in terms of human history, these two factors tend to remain dominant in present day practices.

Perhaps next in order of prominence historically and currently would be the factors of habit, convenience, cost, pleasure, and finally, on the basis of reason and experience, a control that reflects intelligence.

In so far as intelligence serves as a guide, one can go beyond the simple animal controls and anticipate the effects on a long term basis.

Even a modest amount of intelligence offers many advantages. There is an immediate gain, actually, in the added enjoyment of eating. There is also a long range advantage in living more years in good health. If there is any interest or fun in life at all, an intelligent use of food is one of the simplest, surest, and least expensive ways to gain the objective.

In many other parts of the world, the elemental task of getting enough to eat is still the economic and health problem number one. And as emphasized by President Du Bridge,[b] there is good reason for us to be alert to helping those parts of the world where the struggle just to get enough to eat is still severe.

OBSERVATIONS ON THE NUTRITIONAL STATUS OF OUR POPULATION

But here in the United States, there is enough food, and more, to satisfy all our needs for optimum nutrition. The abundance, attractiveness, stability, sanitation and low cost of our food supply all combine to put us within reach of much higher goals in health and enjoyment than we now attain.

There is some underweight among the population, and there is a slight correlation between this condition and tuberculosis. But more often, the underweight condition found in our population is a result of previous sickness or social maladjustment, instead of being a primary cause of broken health.

Within the past two decades, for the first time in our history we have reached a national pattern of food practices that permits almost a complete escape from the classical forms of nutritional deficiency diseases. These diseases still occur in isolated instances, of course, including occasional cases of scurvy, rickets, pellagra, goiter, cheilosis, sprue, convulsions from vitamin B_6 deficiency, and other such conditions. But none of these diseases, caused by a specific deficiency is widespread, as they were in all earlier decades. A large part of this great gain in public health can properly be accredited to the food industry. Part of the gain is from better education, but specific commodities have also been important, such as iodized salt, enriched cereal products, vitamin D milk, citrus products, superior fresh, canned and frozen foods, and fortified margarine.

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, July 1, 1954.

[b] L. A. Du Bridge, "The Inquiring Mind," *Food Technology* (this issue).

Overweight. In contrast with the earlier periods, overweight, as a manifestation of too much body fat, is now probably our most serious form of malnutrition—and it is serious. The records of insurance companies and of the Public Health Service show a significant correlation between overweight and heart disease, diabetes, high blood pressure, hardening of the arteries, liver disease, kidney failure, prenatal malformations, and a shortened life span. These metabolic or chronic and degenerative types of disease are increasingly high on the list of causes of death. They include five of the top seven. Of the other two (cancer in second place and the influenza-pneumonia group in fifth place), only one is distinctly a disease caused by infection. Physicians are still baffled at the cause of arthritis, which is increasingly common, but it is generally regarded as metabolic in origin.

The problem of a balanced intake. Nutrition research personnel, whether they are medically trained or primarily working with experimental animals, are impressed by the evidence that when specific nutrients are studied singly, or when diets as a whole are rated for balanced nutrient content, there is a rather wide zone between the low intake that will result in clear-cut deficiency disease, and the higher intake or better balance that will protect the body in optimum health.

It is very important that we learn where the approximate values are, both for their health significance and for their guidance in regard to costs. But to soften the blows from severe critics, for the delay in discovering optimum values, perhaps we should remember that most of the known nutrients have only been identified within 22 years, and new ones are added every year.

An excellent example of the problem can be cited in the case of fluorine. Although long known to be a normal constituent of bones and teeth, there was no sound basis for associating it with health improvement until a few years ago. Now it is one of the most valuable nutrients for building sound, normal teeth, and can be added to our water supplies with great benefit to the populations where the normal intake is too low. More than a thousand cities in the United States have adopted the practice and other countries are accepting the practice as thoroughly sound. It is a pity that widespread misunderstanding of the evidence in some communities has caused occasional delays and consequent increased suffering, financial losses and permanent physical injury.

The work of Dr. Elvehjem's group and others in studies of amino acid and vitamin balances has served to emphasize the importance of interplay between individual nutrients in securing a balanced intake. Fatty livers are often observed in these tests, under conditions that would not have been suspected in earlier years. Findings of this nature help us understand the widely observed benefits from human and animal diets that are fairly high in good quality protein. The older classical tests to establish minimum protein requirements through short periods would have missed many of these new relationships. Yet the cost of high quality proteins tends to work against urging intakes that are higher than needed. The trend, however, is upward for protein foods in a search for optimum nutrition.

Yet if we look at other parts of the world, we see them surviving surprisingly well on protein intakes that are ridiculously low, in terms of our standards. As the less developed areas reach higher standards of sanitation and medical care in controlling infections, it seems likely that they, too, will press for increased intakes of animal protein foods.

In the case of vitamin C, another example of rising standards of intake for optimum health is evident. Populations can survive on intakes in the range of 20 mg. per day, and guinea pigs can do pretty well on 1 mg. per day. In the case of guinea pigs, there is evidence from controlled, long-term observations, that not less than 5 mg. per day (probably more) will permit optimum health over long periods, such as a life span. The evidence for human populations is not so complete, but it gives at least a strong indication that intakes in the range of 70 mg. or more per day are beneficial for normal adults, with higher intakes being desirable during pregnancy and lactation.

The repair of nutritional injuries. The combined evidence, based on varying one nutrient at a time, in either human or animal tests, and the newer kinds of evidence concerning the importance of maintaining good balances among the nutrients, have been followed by a third kind of evidence, bearing on reversibility of nutritional injuries.

We have tended to accept the thesis that nutritional correction could repair nutritional injury. To a degree, this relationship is fortunately true. There is normally a great capacity for restoring injured tissue, but much of the newer evidence points toward limitation in the repair process. For example, Dr. Best and his associates at Toronto have just reported further evidence that liver, kidney, heart and artery injuries caused by brief periods of choline deficiency are less reversible than generally pictured. Instead of recovering after a deficiency, there was a marked tendency for the degenerative changes to be progressive. They also believe that repeated slight injuries have an effect similar to more intense short periods of acute deficiency. Their work is notable also for pointing out the close association between transitory deposits of abnormal fat in the tissues, and later failure to retain health.

A pattern for optimum nutrition. From a practical point of view, the goal of reaching optimum nutrition for most of our population should be approached educationally, as a necessary supplement to good food products. The "basic seven" pattern has proved useful, and will no doubt continue to have value. But other ideas will likely prove useful too. I think there are several advantages in picturing a good diet, to furnish all the known nutrients regularly and in reasonably balanced sources, in terms of only four major food groups:

(1) Animal protein foods—milk, meat, eggs and fish, with emphasis on extra milk for growing children—to furnish an abundance of amino acids plus vitamins and minerals.
(2) Green leafy and yellow vegetables—broccoli, green beans, carrots, green peas, beet tops, etc.—to furnish minerals in abundance, plus vitamins and fiber.
(3) Citrus fruits, tomatoes and melons—to furnish a generous and reliable source of vitamin C, plus other vitamins and minerals.
(4) Cereals, fats and sugars—to furnish sufficient energy at low cost, plus extra vitamins and minerals in the cereals, but supplied only in quantity to maintain the body weight at its ideal value.

The above grouping has merit in simplicity and in the logic of nutritional service. For advanced work, the same groupings can be expanded in terms of nutrient content and functions, economic factors, and otherwise as desired.

THE RETURNS TO SOCIETY

The returns to society from reaching the goals based on newer concepts of optimum nutrition are much greater than is generally realized. Child and maternal health would be improved distinctly above current levels. Middle-aged working people would have at least better health and working efficiency. And the greatest gains would almost certainly apply to those beyond middle age—in the range from 45 to 70. This is the period when earning power is highest, the strain of responsibility is greatest, and when experience is most valuable to society in organizational and professional service. This is the age group also where the breaks in health are now tragically and needlessly high.

Research advances are steadily adding to the store of reliable information about what must be in each person's food to conserve health. The medical professions and educators are increasingly aware of the advances being made by chemists, physicians and other nutrition scientists. Hence, the food technologist has a greater opportunity than ever before. He can guide the industry in meeting its responsibility and increased service to the public, in ways that are practical and profitable for everyone.

A Comparison of Quality in Eggs Marketed With and Without Refrigeration[a]

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Quality of eggs was determined by breaking samples of each shipment when it left the farm, when it arrived at the second receiver, at the retailer and when sold to the consumer. Refrigeration of eggs in the market channel maintained quality at near the level found when eggs left the farm. The speed of movement of eggs through market channel was of greatest importance when no refrigeration was used.

Although refrigeration is accepted as a practical means of maintaining the quality of most perishable foods during marketing, many eggs marketed at present are not refrigerated. The egg as produced by the hen is a packaged product and is treated much the same as canned goods by many egg handlers, producers, and marketing agencies.

As early as 1910, Pennington and Pierce *(9)* pointed out the value of refrigerating eggs during marketing to maintain quality. This handling was separate from the normal cold storage handling of eggs to be held for extended periods of time prior to offering them for the retail trade. That these early recommendations have not been followed by many egg handlers is reported by Savage *(10)*, Jensen and Stadelman *(6)*, and Dawson and Davidson *(3)*. In these reports it is frequently noted that a farmer cools, or attempts to cool, his eggs by placing them in basement rooms or other areas somewhat cooler than the outside atmospheric temperature. Although none of these same producers would be likely to handle fresh meat or milk in this way, they appear to be satisfied that such handling is adequate for eggs.

The value of refrigeration of eggs on the farm was also urged by Evans and Carver *(5)* in 1942. Lorenz *(8)* called attention in 1946 to the merits of mechanical refrigeration used for farm storage of eggs. He reported that with a refrigerated egg cooling cabinet operated at 55° F., egg quality was maintained at a level well above that of eggs cooled and held in evaporative cooler or other types of egg rooms. Considerable progress has been made in recent years in getting eggs handled as perishable food, but an important volume of eggs are still marketed without refrigeration or with inadequate refrigeration.

Jensen and Stadelman *(7)* reported results which clearly indicated that refrigeration at assembly points and at the other stops in the marketing channel combined with a shortened marketing period are important means for improving the quality of eggs received by the consumer.

In all of the studies reported, one fact stands out—refrigeration is necessary to maintain quality. The present study demonstrates the quantitative effects of refrigeration on quality of eggs at various stages in the marketing channel and when moved through the various marketing stages at different rates of speed.

PROCEDURE

Egg quality was determined at each stage of marketing by candling all eggs into grades on an individual quality basis without tolerance, according to standards as presented by Dice *(4)*. A sample of eggs was taken from each lot of eggs as indicated in Figure 1 and broken out for interior quality (Haugh unit)

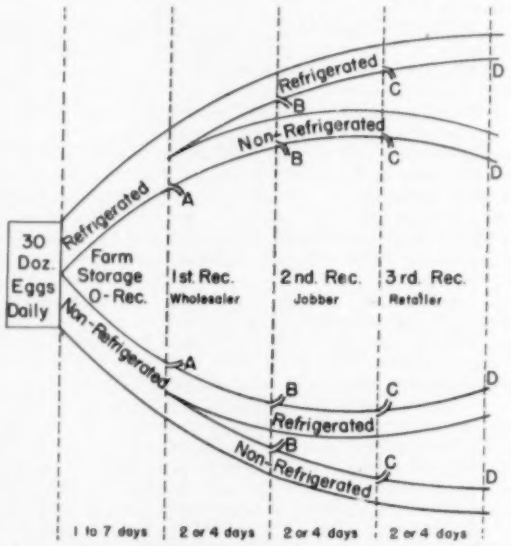

Figure 1. The method for handling eggs produced any one day. The farm storage period varied from 1 to 7 days, with no eggs held on the farm for 4 days.

A. The 15 dozen eggs were candled for quality and a 2-dozen egg sample was selected at random for determination of interior quality by breaking the eggs.

B. The 78 eggs were candled and 16 were selected at random for break-out to determine interior quality.

C. The 62 eggs were candled and 16 were selected at random for break-out to determine interior quality.

D. The 46 eggs were candled and all eggs were broken for determination of interior quality.

determination. The Haugh units were determined by a method described by Brant, Otte, and Norris *(2)*. The Haugh unit is a measure of albumen quality as determined by the height of the thick albumen in relation to the egg weight.

Eggs for this study were obtained during June and July from 2 commercial poultry farms in Western Washington. On each farm there was a walk-in refrigerated egg room and a non-refrigerated egg room. Each farm had a sufficient number of hens so that an adequate supply of eggs of satisfactory quality

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was available for study. A 30-dozen case of eggs was purchased daily from each farm for 3 consecutive days, omitted the fourth day, and continued the 5th, 6th, and 7th days. On each farm, 15 dozen of the daily purchased eggs were stored in the refrigerated egg room, and the remaining 15 dozen placed in the non-refrigerated egg room. Eggs were dated so that records of eggs produced each day could be handled separately throughout the study. The handling of eggs from one farm for one day is outlined in Figure 1. The same procedure was followed for all eggs.

The handling of eggs with respect to refrigeration through the market channels, as shown in Figure 1, was conducted twice for each farm. Eggs moved through the market channel with a 4-day delay at each of the 3 receivers. The entire procedure was then repeated two more times with a 2-day delay at each receiver.

Temperature and humidity conditions of egg storage were recorded on the farm and throughout the marketing period. The maximum, minimum, and mean hourly temperatures are recorded in Table 1. The humidity was checked only as a means of checking for extremes. No such extremes were found. Humidity was not considered, since there is no information suggesting that humidity in the normal ranges, 45 to 65%, relative, has an effect on broken-out albumen quality. A sufficient number of eggs was used so that samples could be taken for interior quality measurements without using cracked or blood spot eggs.

Data obtained on quality of eggs, in terms of Haugh units, have been evaluated on a different basis from those used in the parent study *(1)*. From the results of that study it appeared that, for eggs held at a given temperature, the major factor influencing interior quality was the length of time held. For this reason the analysis here has been confined to estimating the loss of interior egg quality per day held during the marketing process.

RESULTS AND DISCUSSION

The quality loss relationships between eggs produced and marketed under Western Washington summer climatic conditions are presented in Table 2. The non-refrigerated temperatures varied as did the refrigerated temperatures, but in all cases averaged above the refrigerated temperatures (Table 1).

Under the summer conditions encountered, there appeared to be a straight line decline in quality. This decline was at the rate of 0.560 Haugh units per egg per day under refrigerated storage and 1.509 Haugh units per egg per day in the absence of refrigeration. From this it is readily apparent that temperature has a major influence upon maintenance of quality. The average temperature of the refrigerated egg room was 10° F. cooler than the non-refrigerated storage areas.

When farm refrigerated eggs were moved through market channels without refrigeration, or farm non-refrigerated eggs were moved through the 3 receivers (Figure 1) with refrigeration, quality losses paralleled those observed in eggs handled entirely without refrigeration or entirely with refrigeration, respectively. The value of farm refrigeration is apparent only when eggs are delivered to the first receiver. The producer is normally paid for the quality of eggs delivered, making farm refrigeration profitable under conditions of warm weather. The benefits of egg refrigeration on the farm are carried ont to the consumer only when eggs are refrigerated in the market channels.

TABLE 2

The quality in Haugh units of eggs of different ages held with refrigeration and with no refrigeration

Age of Eggs, Days	Non-Refrigerated			Refrigerated		
	Farm 1 Haugh Units	Farm 2 Haugh Units	Average Haugh Units	Farm 1 Haugh Units	Farm 2 Haugh Units	Average Haugh Units
1	76	84	80	75	84	80
2	73	77	75	74	83	79
3	69	78	74	75	80	78
4	68	71	70	73	75	74
5	65	70	68	70	77	74
6	61	70	66	68	76	72
7	62	67	65	70	75	73
8	61	66	64	69	73	71
9	58	63	61	68	75	72
10	54	65	60	66	75	71
11	57	63	60	69	74	72
12	57	70	64	68	74	71
13	53	60	57	67	74	71
14	49	58	54	66	75	71
15	51	54	53	66	73	70
17	48	49	49	67	71	69
18	48	54	51	61	69	65
19	48	57	53	65	70	68
Regression "b"	—1.519	—1.513	—1.509	—0.590	—0.613	—0.560

SUMMARY

The interior quality of fresh eggs was determined at various stages of the normal marketing procedure, using samples of at least 16 eggs. The handling of eggs was controlled so that half of the eggs was refrigerated while held on the farm for from 1 to 7 days and the other half of the eggs was not refrigerated. In marketing, each lot of farm eggs was divided so that half of each refrigerated lot was maintained under refrigeration and half was not. Similarily, the eggs not refrigerated on the farm were divided into 2 lots, one held during market storage under refrigeration and the other not.

The quality of eggs was determined on samples when they left the farm, when moved to the second receiver,

TABLE 1

Temperatures of egg storage facilities used while eggs were held during June and July, 1952

Dates Laid	Treatment	Temperature, in degrees Fahrenheit														
		Farm 1			Farm 2			1st Rec.			2nd Rec.			3rd Rec.		
		Min.	Mean[1]	Max.	Min.	Mean[1]	Max.	Min.	Mean[1]	Max.	Min.	Mean[1]	Max.	Min.	Mean[1]	Max.
6/2–6/9	R[2]	48	49	50	42	51	52	50	53	56	46	49	51	50	53	56
	NR[2]	53	60	68	51	57	60	62	72	83	60	63	70	41	70	86
6/16–6/23	R	48	49	50	42	51	52	46	49	52	46	49	51	48	51	54
	NR	50	59	70	55	56	62	58	66	73	53	65	74	60	62	66
6/25–7/2	R	48	49	50	42	51	52	48	51	54	46	49	51	48	51	54
	NR	52	58	65	55	56	60	60	64	70	58	65	79	55	67	76
7/9–7/16	R	48	49	50	42	51	52	46	50	52	50	53	56	48	51	54
	NR	60	69	81	60	64	70	60	64	67	60	65	91	60	61	66

[1] Weighted average hourly temperature.
[2] R stands for refrigerated; NR for non-refrigerated.

when moved to the retailer, and when sold to the consumer. The time of movement through market channels was controlled so that either 2 days or 4 days elapsed at each stage of marketing (3 handlers).

Farm refrigeration of eggs maintained the quality of eggs sold to the first receiver at a significantly higher level than the quality of eggs not refrigerated on the farm. Refrigeration of eggs in the market channel maintained quality at near the level found when eggs left the farm. Eggs refrigerated on the farm but not refrigerated in market channels for 12 days were of no better quality than eggs that were never refrigerated.

The speed of movement of eggs through the market channel was of greatest importance when no refrigeration was used in the market channel.

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Frozen Food Containers[a,b]

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The various types of rigid, semirigid, and nonrigid frozen food containers are described in terms of their characteristics and adaptations to use with specific commodities. A comparative study of 17 wrapping materials for ground beef is reported. Storage was for 12 months at 0° F. Seven types of containers for frozen ground beef were also studied and their respective performances compared. Storage was at 15°, 0°, and —15° F. for 18 months. Conclusions useful in selecting wrapping materials and containers for frozen foods are offered.

With the advent of freezing as a method of food preservation the development of new protective packaging became necessary. From its beginning about 25 years ago the industry has been handicapped by lack of adequate packaging, and expansion has progressed with the development of suitable packages. When frozen foods were first introduced to consumers, few suitable packages existed and the basic requirements were not known. Containers then in use for other foods were tried with mediocre success. These included wooden barrels, kegs, large tin cans, paper cans and tubs, treated paper bags for fruits, and ice glaze for fish and meats.

As the number of food items frozen commercially and in the home has increased from a few dozen to many hundreds, new packages have been developed. In some cases, as with turkeys, whole chickens, and precooked frozen foods, successful marketing was delayed until protective packages were developed.

The frozen foods industry has been encumbered with too many container sizes—for example, 3 ounces for expensive items like crab meat, 4 ounces for smoked shrimp, 6 ounces for concentrated juices, 8 ounces for meats and juices, 10 ounces for fruit cocktail and some vegetables, and 12 and 16 ounces for most consumer-size packages of fruits, other vegetables, and meats. For institutional use the size of packages for frozen food ranged from 2½, 5, 7½, to 10 pounds. Products for reprocessing were in much larger containers, as 30 pounds for eggs, 50 pounds for peaches and berries, and 200-pound barrels for berries and cherries.

Materials for frozen food containers have been improving for 25 years. Among those which have been tested experimentally and commercially are wood, tin, aluminum plate, aluminum foil, glass, fiberboards and papers, plastics of many kinds; numerous coatings, plasticizers, and laminae as well as glues and inks have also been tested.

The designs of frozen food packages have included many geometric shapes. The most common have been cylindrical, cubical, rectangular, oval, round-tapering, square-tapering, bulge, and those conforming to the contour of the product, as whole turkeys and fish. The trend has been towards the use of containers that fit into production line procedure, as crimped cylindrical cans and rectangular cartons. Packages requiring much

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hand labor for fabrication and closing have been used only for specialty products.

The method of closing containers for frozen foods depends upon the kind of container, but has been standardized chiefly along three lines—crimp sealing tin cans; overwrapping and heat sealing rectangular cartons; and twisting and tying the tops of flexible bags.

Labeling of frozen food containers has improved until lithographing is now standard. Contrasting colors and designs have been found necessary to counteract the opaqueness caused by frosting and to present the product attractively.

REVIEW OF LITERATURE

The comparative merits of packaging materials in protecting the quality of frozen foods have been under investigation since commercial freezing began in the early 1920's. Birdseye *(2)* stated that his company in their search for a moisture-vapor-proof, wet strength, tasteless and odorless material persuaded DuPont to give cellophane a moisture-vapor-proof coating, and thus a promising film was developed.

In 1930, Woodroof *(22, 23)* reported results from experiments with 32 kinds of containers for frozen foods, varying in size from two to 24 ounces. Included were 4 types of paperboard containers, 3 of glass, one of tin, one of aluminum, and 3 wrapping materials. In the same year, Woodroof and Bailey *(24)* reported results from the use of paperboard, tin, aluminum, and glass containers. They found that aluminum foil, cellophane, and coated parchment wrappers gave good results with frozen figs. Later, Woodroof and DuPree *(25)* gave the results of the loss of weight from 5 products packed in about 100 kinds and combinations of packaging materials. They found that paraffin was very effective in preventing moisture and flavor loss when properly applied to cartons or wrapping materials. They also found that when a moisture impervious bag was used it mattered little whether or not it was placed in a carton and there was no protective value from the use of an overwrap. Some of the most efficient containers were of laminated materials with a moisture impervious sheet and an outer layer of tough material to prevent tearing.

McCoy and his associates *(9)* from their study of 32 wrapping materials rated 13 as satisfactory for frozen food. They found that the overall performance of aluminum foil, cellophane, and pliofilm was superior to that of laminates and papers. The laminates were too stiff to apply closely to the product and delaminated during freezing storage, but were more moisture-vapor-proof than the papers tested. Winters *(21)* tested the moisture transmission rate of 22 materials including cartons, bags, and sheets of waxed paper, aluminum foil, and films. He found the losses through aluminum foil, pliofilm, cellophane, and their laminates were less than one percent, whereas losses through waxed papers were as high as 7.6%.

Carlin *(3)* stated that when fats were absorbed by packaging materials a larger surface area was exposed to atmospheric oxygen and the development of rancidity was greatly accelerated. Lavers *(7)* tested the greaseproof qualities of several materials and reported that cellophane, pliofilm, and vinyl derivatives ranked first in preventing grease permeability, followed by polyethylene, glassine, vegetable parchments, "greaseproof" papers, and waxed papers, in the order named.

Throckmorton *(19)* stated that the most universal problem in packaging food was to prevent the transfer of gases and vapors through the walls of the container. Steinberg *et al. (17)* showed a significant decrease in palatability with an increasing oxygen content surrounding meat. Robertson *(16)* reported excellent meat storage life was possible in gastight containers such as tin cans and vacuum sealed glass jars. Others who recommended tin containers were Pennington *(12)*, Heerdt *(6)*, Pottinger and Associates *(13)*, Stewart and Lowe *(18)*, and Willis *et al. (20)*.

According to DuBois, Tressler, and Fenton *(4)* flavor changes and moisture losses were noted first in frozen poultry wrapped in waxed locker paper, next in poultry wrapped in coated sulfite paper, and last in that wrapped in latex. Masterman and Winsor *(8)* demonstrated that little weight was lost from foods packaged in cellophane, but the loss was as high as 3.74% in 6 months when wrapped in locker papers. Nicholas *(10)* presented data to show that after 4 years at 0° F. pork shoulders wrapped in cellophane lost from 0.17 to 1.65% of the original moisture content, while those in kraft paper, waxed on one side, lost from 10.4 to 11.15%. The latter samples were desiccated and discolored over the entire surface. Atkinson *et al. (1, 26)*, after studying the suitability of certain materials for wrapping frozen sausage, meat, and poultry, pointed out that aluminum foil afforded the best protection followed in order by pliofilm, cellophane, and waxed locker paper.

Pottinger and coworkers *(13)* found, in a six-month period, no moisture losses from oysters packed in either single, duplex, or laminated cellophane bags. Losses were negligible from oysters in specially coated sulfite bags, and there was 1.2% moisture loss from those in waxed paper bags. Ramsbottom *(15)* concluded that moisture-resistant cellophane, pliofilm, and Cry-O-Vac rubber latex were equally effective in minimizing desiccation, and in protecting flavor and color of steaks stored at 0° for 7 years.

Stewart and Lowe *(18)* recommended aluminum foil, pliofilm, Saran, polyethylene, and Cry-O-Rap for protecting eviscerated poultry during freezing storage. Cellophane was slightly less efficient than the wraps recommended, and waxed paper and paperboard cartons were less satisfactory than cellophane. Emerson, Brady, and Tucker *(5)* reported no significant difference in .0015" aluminum foil, 300 MSAT cellophane, and glassine laminated to 30-pound kraft paper for retaining moisture and desirable flavor and color in frozen beef. Palmer *et al. (11)* reported moisture lost from frozen meat in waxed paper was five times greater than in laminated papers.

In an effort to standardize packages for frozen foods the National Association of Frozen Food Packers together with the U. S. Department of Commerce have issued simplified practice recommendations to producers, distributors, and other handlers of consumer-size packages of certain frozen fruits and vegetables. The recommendation proposes standard container sizes (net weight) for 16 vegetables and 3 fruits *(14)*. Proposals for other products may be expected to follow.

GENERAL METHODS

Assembling data for this report began in 1928 when practically all consumer-size containers that were then thought suitable for frozen foods were evaluated. Those used in these investigations included 2 types of aluminum cans, numerous sizes of lacquered and unlacquered tin cans, several types of glass containers, fiber canisters, aluminum foil, parchment, waxed paper, and other wrapping materials. The products packed were peaches, strawberries, figs, muscadine grape pulp, blackberries, most common vegetables, bakery products, sausage, ground beef, and chicken.

During the intervening 25 years, an effort has been made to study and evaluate frozen food containers as they have been developed. These experiments have been conducted in cooperation with the manufacturer, commercial packers, freezer locker plants, and homemakers. In general, the procedure has been to test each packaging material or type of container by actually using it for foods in the manner recommended by the manufacturer. The packaged foods were placed in storage at 0° F. Samples were withdrawn at intervals at 3, 6, 9, and 12 months for examination of both the food product and the container. Sensory tests were used to evaluate the appearance, color, aroma, texture, and flavor of the product either in the frozen state or after defrosting and in some cases after cooking. In addition, chemical or physical determinations were made on certain samples to measure possible development of rancidity, loss in weight and flavor, and change in texture and color during storage.

RESULTS OF STUDY

The results of this study are presented under (a) classification of containers, together with their adaptability as determined from specific experiments and general observations; and (b) behavior of containers, as determined from three experiments with the types most commonly used at that time.

CLASSIFICATION OF CONTAINERS

Frozen food containers may be classified into 3 general types —rigid, semirigid, and nonrigid. Each of these types may be subclassified as follows:

Rigid Containers

Tin cans. Ease of filling and closing, sanitation, economy, rapidity of freezing, protection of the product, and finally the ease of thawing and emptying, make tin cans the best of rigid frozen food containers. Other favorable characteristics are (a) their availability in sizes having a capacity ranging from a few ounces to more than 50 pounds, (b) closures may be crimped (Figure B 7), slip-over (Figure B 8), slip-in or screw cap (Figure B 9) (c) the empty cans have considerable re-use value. Use of consumer-size tin cans for frozen concentrated juices, berries, peaches, shrimp, and meats has increased steadily for the past 10 years.

Rectangular tin cans (Figure B 10) have been successful in the home because, compared with round cans, they permit easier stacking, more rapid freezing, more economical use of storage space, and are less likely to be mistaken for and therefore handled like unfrozen canned foods. A modification of the rectangular cans, having metal ends and fiber walls, has proven popular for fruits with syrup and for fruit purees.

Paper cans, tumblers, and tubs. These must be heavily paraffined. They may be obtained in sizes ranging from a few ounces to more than 30 pounds, with slip-in (Figure B 3, 4) or slip-over (Figure B 5, 6) lids; many weights of material and coatings are used. Only boards of close texture, waxed on both sides, and with from 10 to 12 pounds of good paraffin per ream (500 sheets, 24 x 36 in.) were found to withstand handling and to protect the product from change of weight or flavor. Efficiency was found to depend upon the shape, construction, and coating of the container. Dip coating after forming is desirable to prevent leaks, and a soft padding beneath the slip-over lid of tumblers (Figure B 6) permits the lids to fit snugly.

Glass containers. Widemouthed glass containers (Figure D 1, 2) have been found suitable for freezing in the home and in locker plants, as well as for specialty products to be marketed. Straight or tapering sides permit easy filling and emptying, and allow the product to expand without cracking the container. They may be reused.

Plastic containers. Plastic containers (Figure D 3, 4, 5) are of many sizes, shapes, and colors; they are semitransparent, semifragile, and reusable. While well suited for the home, commercial use has been limited due to high cost and lids that do not fit properly.

Aluminum trays and cans. Rigid, rectangular, reusable aluminum trays, with slip-in lids, in pint and quart sizes, have been found useful for home freezing. Due to the cost and difficulties in securely closing and labeling, these trays have not been used commercially. For more than 30 years, unsuccessful attempts have been made to introduce aluminum cans for frozen foods. The many advantages of such containers have been outweighed by the high cost, difficulty of closing, and ease of denting.

Wooden barrels. Except for fruits, vegetables, and certain meats destined for reprocessing, wooden barrels have been replaced by lighter, smaller, and more efficient containers of other materials.

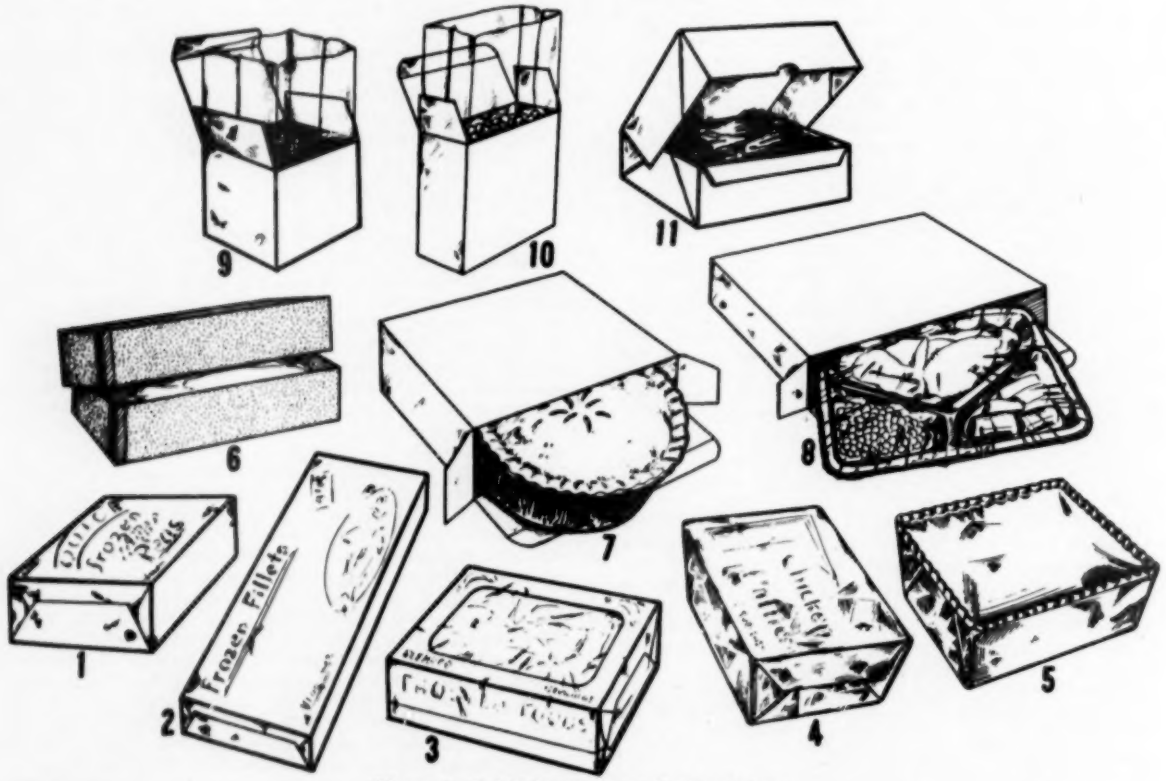

Figure A. Brick-shaped frozen food containers

1. Peter's type carton, overwrapped with waxed paper or cellophane, used primarily for 10 and 12 ounces of vegetables.
2. Same as 1, except more elongated, used for fish.
3. Same as 1, with transparent window.
4. Aluminum foil tray with tapering sides, covered with waxed paperboard and overwrapped with aluminum foil, used for cooked foods intended for reheating.
5. Same as 4, with crimped aluminum foil lid.
6. Telescope carton with taped corners, for already packaged products.
7. Aluminum foil bake-in pan in end-opening sulfite board carton, used for pies and other cooked products.
8. Stamped aluminum, divided tray in end-opening carton, used for frozen dinners.
9. Bag-in-cubical carton, used mostly in the home for fruits, vegetables, or cooked foods.
10. Same as 9, except for shape.
11. Same as 1, may be aluminum foil lined.

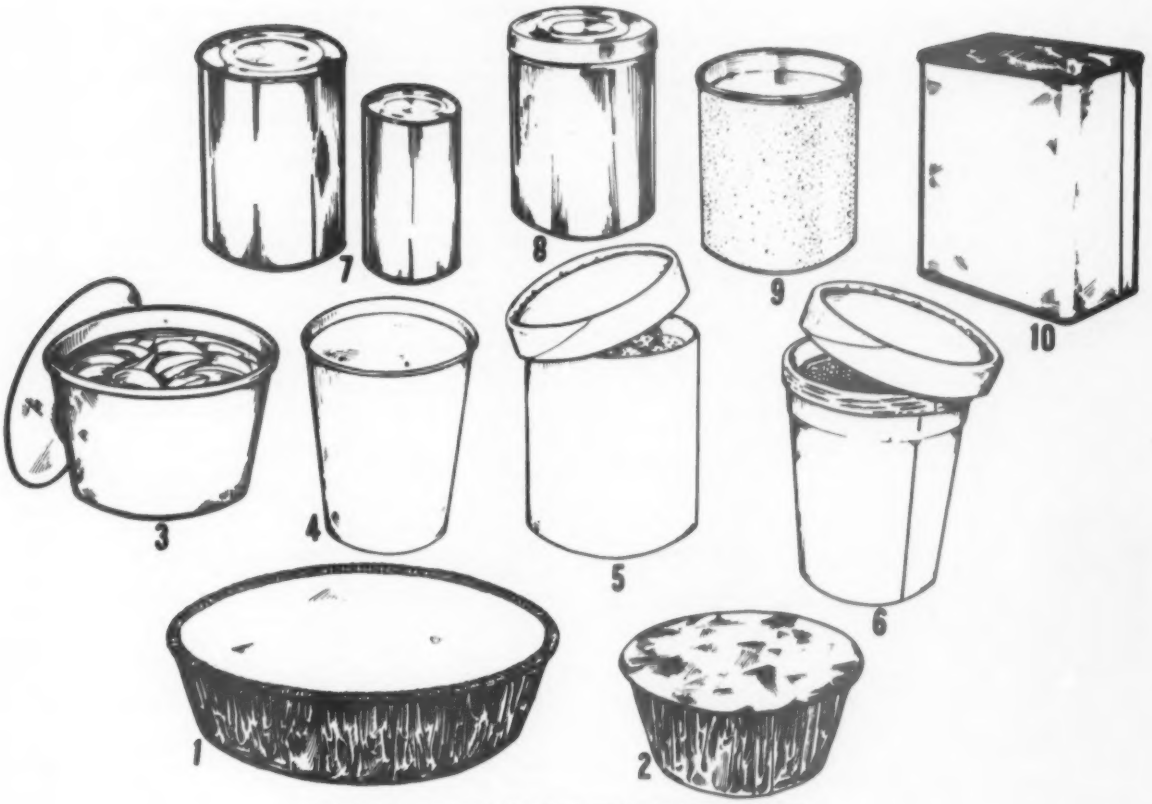

Figure B. Frozen food rigid and semirigid containers

1. Aluminum foil bake-in pan, with crimped-on sulfite lid, for cooked foods intended for reheating.
2. Same as 1, except with crimped-on aluminum foil lid.
3. Paraffined, sulfite board tub, with slip-in lid, used mostly in the home for soft foods.
4. Same as 3, except tumbler-shaped.
5. Sulfite board canister, cellophane lined with slip-over lid, used as 3.
6. Sulfite board tumbler, polyethylene lined with lid slipped over cushion flange, used as 3.
7. Tin cans, with crimped lids, used principally for fruits and juices.
8. Tin can with slip-over lid, used mostly in institutional sizes for many products.
9. Fully enameled tin can with slip-in-lid, used in the home.
10. Rectangular fiberboard carton with metal ends, used mostly for fruits.

Semirigid Containers

Rectangular paperboard cartons. The efficiency of rectangular paperboard cartons is dependent upon design, construction, and coating. The types used are:

Peter's type. These folding cartons with locking covers are most popular for consumer-size packages of vegetables, meats, and fruits packed without syrup. This type is available in several shapes and materials (Figure A 1, 3, 11).

Two-piece telescope cartons. Available with either taped (Figure A 6) or stitched corners, these cartons are used mostly in institutional sizes for vegetables, meats, and bakery products. They are especially easy to fill and to open for inspection or emptying of contents.

Open-end, semirigid cartons. These are used for pies and come in semirigid foil or fiber pans (Figure A 7) or for frozen prepared dinners in partitioned aluminum trays (Figure A 8). They are suitable for bakery goods, precooked meats, and other products with quick turnover.

Bag-in-box combination. This type is in more general use in homes and locker plants than in commercial operations. The cubical (Figure A 9) or elongated (Figure A 10) types are used for many products, particularly vegetables and syrup-packed fruits. In recent years this combination has been gradually replaced by more convenient, rigid, reusable containers (Figure D 4, 5).

Aluminum foil containers. Tapering rectangular aluminum foil trays are becoming more common for specialty products with a quick turnover on the market. Foil dishes are particularly useful for semiliquid mixtures or pastries which require heating before serving. Some foil containers are rectangular with either straight or sloping sides, while others are round and of varying diameters and depths. The covers may be either crimped-on foil or cardboard (Figure A 5); the latter requires a foil overwrap (Figure A 4). Usually the foil packages are protected by semirigid paper cartons (Figure A 7).

Fiber plates. These have a limited use for prebaked pies and rolls and for frozen complete meals (Figure A 7, 8). Fiber plates are cheaper than aluminum foil, but may become grease- or water-soaked and are unsuitable for heating.

Nonrigid Containers

Bags. Some of the most economical as well as the most efficient frozen food packages are bags of Cry-O-Rap, rubber hydrochloride (pliofilm), polyvinylidene chloride (Saran), polyvinal chloride (Visten), or plain polyethylene (Figure C 5). These materials are transparent, elastic, and flexible at all temperatures and the containers can be heat sealed. Moreover, no deterioration in their condition is evident after several years at 0° F. Bags of most of these materials may be closed under vacuum and made to fit almost skintight around fowl or irregular cuts of meat. In addition, some of them may be heat shrunk about the product. These films are sometimes laminated to foil, tissues, or boards, and may thereby lose certain desirable characteristics. It has been found that by using films of double thickness lamination is unnecessary and a semirigid carton (Figure A 9, 10) is not required. These bags, tightly fitted around the product, practically eliminate "freezer burn" on whole chickens, turkeys, and cut-up meats.

Figure C. Protective covering for frozen meats

1. Ice-glazed fish.
2. Meat wrapped butcher's style in laminated sulfite paper.
3. Ice-glazed shrimp in end-opened carton.
4. Meat wrapped confectioner's style in aluminum foil.
5. Chicken in polyvinylidene chloride bag, vacuumized and heat-shrunk.

Figure D. Rigid and semirigid containers

1. Glass freezer jar with tapered sides and screw cap, used extensively in the home and locker plants.
2. Glass freezer jar with straight sides and clamped-on glass lid, used occasionally in the home.
3. Polyethylene squeeze bottle for juices.
4. Cylindrical polystyrene jar with straight sides and slip-over lid, used as 2.
5. Rectangular polyethylene carton with tapered sides and slip-over lid, used as 1.

Wrappers. Although cellophane formerly was preferred, others are being used in increasing amounts. Improvements in wrapping materials are being stimulated by the current interest in precut and wrapped frozen meats. The following are the most commonly used:

Aluminum foil. When properly used, .001- or .0015-inch plain aluminum foil has proved to be an extremely efficient wrapping material for chickens, turkeys, or other ready-to-cook products with irregular shape, and for overwrapping cartons (Figure A 4). Application is by covering the object with a single sheet of foil and gently pressing tightly into place. In this way the foil is "molded" to the product without adhesive or tape. In recent years this method has given way to evacuated, transparent bags (Figure C 5) for poultry. Most meats or poultry may be cooked with only partial removal of the plain foil.

Aluminum foil (.0005 inch) is used extensively for laminating to paper, acetate film, polyethylene (0.001 gauge), other sheets or to boards. Most of these are heat sealable, have considerable strength, as well as the protective qualities of plain foil, as shown in Tables 1 and 2. Laminated foil cannot be used for cooking.

Moisture- and water-resistant cellophanes. These materials owe their special properties to lacquer coatings applied to the surface. The lacquers usually serve a dual purpose—to produce a moisture- and water-resistant surface and to provide a thermoplastic film which acts as a heat sealing medium. When properly sealed, most coated cellophanes supply a dependable protection because the flexibility of the lacquer is not ordinarily affected by low temperatures. Water-vapor-resistant cellophane is designed primarily to resist the passage of water vapor and hence is of value in protecting dry-frozen commodities. Wet packs, such as fruit in syrup, require the use of special water-resistant films. The best sealing temperatures vary somewhat, depending upon the characteristics of the lacquer, but generally lie between 285° and 385° F.

Waxed (paraffined) papers. Waxed papers are preferred by many because of the low cost. There are two general classifications: (a) coated on both sides and (b) coated on one side. Both types are supplied for packaging frozen foods, but only (a) possesses the essential qualifications for adequate protection. The amount and kind of paraffin largely determine the value of the paper. Generally, a medium-weight paper waxed on both sides with from 10 to 12 pounds of suitable paraffin per ream (500 sheets, 24 x 36 inches) is the most satisfactory. Papers with close texture are more desirable than loose-textured ones.

TABLE 1

Description and properties of seventeen packaging materials for frozen foods, listed in order of increasing amount of moisture loss from ground beef during twelve months' storage at 0° F.[1]

Code no.	Description			Clarity	Heat		Ease of application	Durability in handling	Resistance to penetration of	
	Base sheet	Secondary sheet	Treatment		Sealabilty and range	0° F.			oil	acid
1	.0015" Aluminum foil	.....	.....	opaque	none	.....	excellent	poor	excellent	excellent
2	.001" Aluminum foil	.....	heat-seal coated	opaque	good	200-300	excellent	poor	excellent	excellent
3	.001" Aluminum foil	.001" Polyethylene film	laminated	opaque	good	200-300	excellent	fair	excellent	excellent
4	.0005" Aluminum foil	.001" Polyethylene film	laminated	opaque	good	200-300	excellent	fair	excellent	excellent
5	.00075" Polyvinylidene chloride film	.....	.....	transparent	good	.....	.....	fair to good	excellent	excellent
6	.001" Rubber hydrochloride film	.....	.....	translucent	excellent	250-350	good	excellent	excellent	excellent
7	Aluminum foil	tissue	laminated	opaque	none	.....	fair	good	good	good
8	.002" Polyethylene film	.....	.....	translucent	excellent	200-300	good	excellent	excellent	excellent
9	White kraft paper	white kraft paper	laminated and wax coated	opaque	none	.....	poor	very good	fair	good
10	42-lb. White kraft paper	.....	8-lb. polyethylene coated	opaque	good	275-375	fair	good	fair	good
11	.002" Vinyl-nitrile film	.....	.....	transparent	excellent	325-400	good	fair to good	excellent	excellent
12	.00035" Aluminum foil	40-lb Natural kraft paper	laminated	opaque	none	.....	fair	good	good	good
13	White kraft paper	glassine	laminated	opaque	none	.....	poor	very good	fair	good
14	14-lb. White kraft paper	36-lb Plasticized white kraft paper	laminated and wax coated	opaque	none	.....	poor	very good	very poor	good
15	.0014" Cellophane MSB-3	.....	.....	transparent	excellent	200-400	good	fair	excellent	excellent
16	.001" Polystyrene film	.....	.....	transparent	none	.....	poor	very poor	excellent	excellent
17	40-lb. White kraft paper	.....	wax coated one side	opaque	none	.....	fair	fair	very poor	poor

[1] As shown in Table 2.

TABLE 2

Moisture losses, peroxide values, free fatty acid content and sensory values of ground beef stored 12 months at 0° F. in 17 packaging materials [1]

Code no.	Moisture loss	Chemical analysis		Sensory values [2]			
		Peroxide value	Free fatty acid content	Aroma	Color	Texture	Flavor
	percent	*m.e./kg. fat*	*percent as oleic*	(9-1)	(9-1)	(9-1)	(9-1)
1	0.07	14.2	5.65	6.7	8.0	7.5	7.1
2	0.09	9.5	5.67	7.1	8.0	7.3	7.1
3	0.19	11.7	5.65	7.1	8.0	7.3	7.2
4	0.19	11.7	5.67	7.1	8.0	7.4	7.1
5	0.19	13.0	6.04	7.1	8.1	7.4	7.3
6	0.21	12.6	5.93	6.5	8.0	7.6	7.0
7	0.25	9.8	6.24	7.4	7.8	7.4	7.1
8	0.37	11.9	5.25	6.4	7.9	6.9	6.8
9	0.38	12.9	5.14	6.6	8.0	6.8	6.6
10	0.38	12.8	5.15	6.8	8.0	7.6	6.8
11	0.48	11.7	5.39	7.1	8.0	6.8	7.2
12	0.48	9.8	5.88	7.1	8.0	7.6	7.2
13	0.89	15.6	5.49	7.4	7.8	7.1	7.1
14	1.49	10.6	4.62	6.6	7.9	6.6	7.2
15	1.57	12.7	5.96	6.3	8.0	6.5	6.2
16	3.38	16.5	5.81	6.7	7.6	6.9	6.7
17	3.88	15.8	5.29	6.5	7.6	7.2	7.0

[1] As shown in Table 1.
[2] Scores range from *excellent* (9), *unacceptable* (4.5), to *very poor* (1).

Coated papers of this type may be heat sealed and employed as bags, bag liners, or overwraps; they supply fairly effective protection against moisture loss provided the sealing is carefully done.

The principal disadvantage of ordinary waxed paper is that it loses effectiveness when subjected to folding or rough handling; fractures and ruptures in the paraffin coatings result. Frozen foods protected by waxed paper should be carefully handled at all times. Double bags or double overwraps of waxed paper markedly increase the degree of protection.

Polyethylene film. Relatively new and replacing many of the formerly used flexible, transparent sheets, this material is easily fabricated, resistant to moisture-vapor and odors, and semipermeable to oxygen. It may be stretched to accommodate odd-shaped packages, is flexible at very low temperatures, is heat sealable, does not deteriorate rapidly at ordinary temperatures, may be washed and reused, will withstand a vacuum, and is relatively cheap.

Polyvinylidene chloride (Saran). This new crystal clear film is the most resistant of all commercial films to moisture, odor, or flavor transmission. However, it is the most expensive. At low temperatures it becomes quite brittle. Other properties are similar to polyethylene.

Cry-O-Rap. This Saran-resin combination is similar to polyethylene with the added advantage that it can be heat shrunk to fit skintight around irregular materials. The bags are especially suited to packaging whole fowls.

Rubber hydrochloride (pliofilm). Readily heat sealable, moisture resistant, greaseproof, clear, resilient, and tough, it is unfortunate that its use is declining because of its rubber-like odor, and because it becomes brittle with age.

Laminated materials. Lamination creates a durable and efficient sheet which usually supplies greater protection than single-sheet materials (Figure C 2). Various types are available—paper to paper, cellophane to paper, cellophane to cellophane, cellophane to aluminum foil to paper, etc. Laminated materials coated with a heat sealable substance on both surfaces are satisfactory for overwrapping. Those coated on only one surface may be effectively utilized when fashioned into pouches by heat sealing. Because of the greater durability and puncture resistance of laminated materials, they are more dependable for packaging and handling irregularly shaped frozen foods, such as meat or poultry, than most single films. Performance of these materials is dependent to a great extent upon the tightness of the sealing.

Glazing. Dipping frozen products into cold water to produce a uniform ice glaze over the product was the first method of protecting frozen meats against "freezer burn." This method has been used extensively in the past for protecting whole fresh hams, and other pork cuts, fish (Figure C 1), and shrimp (Figure 3), but is being steadily replaced by bags, wraps, and cartons. Since it was found necessary to reglaze with ice several times each year to replace that lost by evaporation, a nonvolatile, plasticized microcrystalline paraffin has been developed for coating frozen meats.

Dip coating. This procedure is simple, involving only coating the frozen product by dipping it in a molten thermoplastic mixture. Upon coming in contact with the cold surface of the commodity or the package surrounding it, the dip coating solidifies and forms a continuous protective film which completely envelopes the product with a closely attached covering. This process eliminates the weaknesses of heat-sealed closures, supplies a barrier which protects the product against contact with air, and prevents loss of water vapor to the surrounding atmosphere. Frozen foods packaged in this manner retain quality for long periods, if stored at reasonably constant and low temperatures, because the method reduces oxidation, loss of moisture, and "freezer burn." The coated product may be placed in a bag or carton or stored without further packaging. As a variation of this method, the material may be packed tightly in cartons or bags and then dipped in the thermoplastic coating after freezing. The virtue of dip coatings lies in low cost and efficiency in preventing desiccation.

BEHAVIOR OF CONTAINERS AND WRAPPING MATERIALS FOR FROZEN FOODS

Numerous tests were made in an attempt to evaluate the behavior of frozen food containers and wrapping materials. The results of four of these are reported briefly below.

Comparison of seventeen wrapping materials for ground beef. Tests were made in which one-pound portions of ground beef were wrapped, confectioner's style, in 17 wrapping materials and held in storage for 12 months at 0° F. Weighings were made periodically, while in storage, and chemical and sensory evaluations of the product were made at the end of the period. Data were obtained for each material on the heat sealability, resistance to acid, oil, grease, and moisture penetration, durability during handling, ease of application, dimensional stability, clarity, and its characteristics to protect the quality of the beef. These together with a description of the wrapping materials tested are presented in Tables 1 and 2.

Sealability. Good seals were obtained at temperatures of 150° to 250° F. with polyethylene coated kraft, cellophane, or aluminum foil, provided the coated sides were in contact. Excellent seals resulted at 150° to 200° F. when a shield or mask of paper was inserted between the heated sealer jaws and films of polyethylene, polyvinylidene chloride, and vinyl-nitrite rubber. Rubber hydrochloride films sealed best at a temperature slightly below 300°; and cellophane sealed at 200°-400° F. temperature range.

Grease and oil penetration. All films, including cellophane and foil, were excellent barriers to grease. Kraft paper became grease stained readily, whether waxed or laminated to any of the other materials used. Grease penetrated waxed papers, glassine, or foil at the points where they were folded or creased.

Acid penetration. The acid used (vinegar, the equivalent of 5% acetic acid) penetrated only a few of the materials and then only slightly. No penetration was detected in the case of plain foil, cellophane, or the other films; slight penetration was observed with glassine or kraft pouches, whether waxed or laminated to foil.

Durability in handling. Wraps of rubber hydrochloride and polyethylene were least affected by tumbling cartons of frozen food in a 12 x 12 x 30 in. wooden box with 2-in.-wide baffles located on opposite sides 10 inches from the ends. Damage to kraft wraps, either single sheets or laminants, was limited to scuffing, and only small tears were found in any of the films. Although tumbling caused numerous pinholes and several larger holes in the plain and heat sealable aluminum foils, that laminated to polyethylene, kraft, and tissue was damaged less.

Ease of application. The following remarks refer only to hand wrapping. Plain, heat sealable, and polyethylene-coated aluminum foils were the easiest of the 17 materials to mold closely to, and fasten securely around, rolls of ground beef. Adhesion of the other films to the beef was slightly less than that of the aluminum foil, but the lack of dead folding in the films decreased their ease of application. Bulkiness of the kraft paper, plain or laminated, and kraft laminates, and lack of flexibility of the polystyrene film made these materials difficult to use.

Protection of ground beef. Desiccation was negligible when the ground beef was wrapped in aluminum foil and aluminum foil laminants. Very small areas of desiccated tissue were noted at points of folds in film wrapped beef, and slightly larger areas were noted when kraft was used. A considerable amount of desiccation was found in the beef wrapped in polystyrene film.

Less than 1% moisture was lost from beef wrapped in 12 of the materials tested, as shown in Table 2. Between 1 and 2% was lost from the beef wrapped in MSB-3 cellophane alone or in white, 14 lb. kraft on 36 lb. plasticized kraft. The greatest losses (3.38 and 3.88%) were from the beef wrapped in polystyrene film or in kraft paper, waxed on one side.

Peroxide values of the fat were least in the meat wrapped in heat sealable aluminum foil, rubber hydrochloride, and kraft laminated to aluminum foil, and highest when the wrapping materials were glassine laminated to kraft, kraft waxed on one side, and polyethylene film. Free fatty acid content of the meat varied from 6.24 to 4.62%. That wrapped in polyvinylidene chloride and in aluminum foil laminated to tissue had a free fatty acid content above 6.0%. The free fatty acid content was below 5.0% when kraft laminated to kraft was used; and in cases of all of the other materials it varied from 5.0 to 6.0%.

Sensory evaluations of the ground beef showed no significant differences in the color, aroma, texture, and flavor, regardless of the wrapping material. Color values ranged from good to very good and values for other factors ranged from low good to good.

Comparison of seven types of packages for frozen ground beef. One-half-pound lots of ground beef were formed into rolls about 2 inches in diameter and then packed into glass freezer jars (Figure D 1) or frosted tin cans (Figure B 9), or wrapped in polyethylene (.002), pliofilm (120 FF), cellophane (.300 MSAT), aluminum foil (.0015), or laminated sulfite sheets (Figure C 4). Storage was at 15°, 0°, and —15° F. for 18 months. At intervals of one month the position of each package was shifted; at intervals of 6 months each package was weighed. After 18 months' storage, determinations of rancidity and evaluations of appearance, aroma, color, texture, and flavor were made.

The meat in the tightly packed glass jars and tin cans was slightly discolored at the top, due to air in the head space. When the meat was loosely packed in the jars or cans, cavity ice, desiccation, and grayness developed. There was no cavity ice in the foil or polyethylene packages, and discoloration and desiccation were confined to a very narrow line at the closure. The products wrapped in cellophane and in laminated paper showed grayness, which increased in depth and area as the storage temperature increased. At 15° F. the entire surface of the roll was gray to a depth of about 3/16 inch, while at —15° F. the gray areas were very small, near the closures, and not more than 1/8-inch deep. The interior of the rolls was deep pink similar to that of freshly ground meat.

Losses in weight of ground beef stored 18 months at 0° F., in glass jars, tin cans, aluminum foil, or polyethylene were 0.38% or less; in laminated paper 1.1%; in cellophane 3.1%; and in pliofilm 3.9%.

Other than the method of packaging, storage temperature was the dominant factor in loss in weight from frozen ground beef. When wrapped in laminated paper the loss at 15° F. was three times that stored at 0°, and four times that stored at —15° F. Losses in weight of this product wrapped in aluminum foil were similar to those from glass jars and tin cans which ranged from none at —15° to 0.4% at 15° F.

There were wide differences in the aroma and flavor of the cooked beef after storage, due to methods of packaging. That in glass jars was rated *very good*, that in tin cans and polyethylene wrappers was *good*, that in aluminum foil and laminated paper was *fair*, while that in pliofilm and cellophane rated *below fair*. The beef that was rated fair or below was slightly rancid.

After being cooked, the color of the beef packed in glass jars, tin cans or wrapped in polyethylene was rated *very good*, while all the other lots were *good*. The texture of those lots which lost the most moisture was driest after being cooked.

From results of this test the 7 methods of packaging may be listed in order of desirability of the product: glass jars, tin cans, polyethylene wrap, aluminum foil wrap, laminated sulfite paper wrap, cellophane wrap, and pliofilm wrap.

Comparison of glass jars, paperboard cans, aluminum foil, and laminated paper for cut-up broilers. Breasts, drumsticks, and thighs of broilers were taken from a commercial production line and packed: (a) in pint glass freezer jars (Figure D 1) with and without water, and in an atmosphere of carbon dioxide and nitrogen; (b) in pint paperboard cans (Figure B 5) with and without water; (c) in aluminum foil, .0015-inch (Figure C 4); and (d) in 2 sheets of sulfite kraft paper laminated together and waxed (Figure C 2). Storage was at 0° F. for 12 months.

Fat was extracted from a composite of the 3 cuts and free fatty acids and peroxide values were determined initially and after 6 and 12 months' storage. Each package was weighed before freezing and at bi-monthly intervals thereafter; each piece of chicken was weighed at the beginning and end of the experiment. The product was prepared for sensory evaluation by coating each piece with salted flour and frying at 375° F.

There was no weight loss from the products in glass, less than 0.5% when aluminum foil was used, and less than 1.0% from laminated kraft wrappers. The chicken in paper cans and covered with water lost 15.3%, and that in similar cartons without water lost 10.7% in weight. The cartons with water had 1/4- to 1/2-inch space between the contents and the carton walls, indicating that a portion of the weight loss was evaporation of the added water.

Drumsticks lost less than thighs or breasts during freezing, thawing, and storing, indicating the protective value of the skin. Also, pieces in the center of the pack lost less weight than similar cuts at the outside of the pack. The individual pieces packed in water lost less than those in air, carbon dioxide, or nitrogen.

The results from this experiment show that differences in flavor were small, and only in the samples in the paperboard cans, with air, was any off flavor noted. This was the only type of package that seemed to justify the use of water as a covering for the product. No significant differences in aroma, color, texture, peroxide value, or free fatty acids of the cut-up broilers were found that could be traced to methods of packaging used in this experiment.

Comparison of six kinds of packages for Brunswick stew. Freshly made Brunswick stew was packed in glass freezer jars (Figure D 1), waxed paperboard tubs (Figure B 3), and in box-with-bag (Figure A 9) of cellophane, pliofilm, polyethylene, and aluminum foil. All packages were filled, sealed, and stored at 0° F. for 14 months.

Losses in weight during storage from the different types of packs were: none from glass jars, aluminum foil bag-in-box,

polyethylene bag-in-box, or pliofilm bag-in-box; 3.6% from cellophane bag-in-box, and 9.0% from waxed paperboard tubs. The amount of loss due to desiccation was in proportion to depth to which drying occurred. All of the packages had considerable cavity ice except glass jars which had very little and aluminum foil which had none.

There was considerable difference in the flavor of the reheated stew that could be related to the type of package. The flavor of the stew in glass jars and aluminum foil was excellent, that in cellophane and polyethylene was good, while that in pliofilm or waxed cartons was only fair. The flavor of the pepper was accentuated in all types of packages, while that of the meat, onions, tomatoes, corn, salt, and catsup was so blended that identification of individual flavors was difficult. The color and consistency of the stew in all of the packs were excellent regardless of the type of package.

SUMMARY

Materials and containers for frozen foods were tested, including tin cans, aluminum cans, glass jars, aluminum foil, rigid fiberboards, flexible fiber sheets, transparent boards and sheets of a number of materials, as well as many types of laminations of sheets-to-sheets, sheets-to-boards, and boards-to-boards.

The leading types of containers are: hermetically sealed tin cans for concentrated juices and many fruits in syrup; semirigid Peter's type carton, with moisture-vapor-proof overwrap, for most commercially packed fruits and vegetables; aluminum foil or nonrigid bags which can be packed under vacuum and heat shrunk, for fowls or irregular cuts of meats; aluminum foil dishes, with crimped foil covers, for precooked products which require heating for serving; and rigid, leakproof, reusable containers primarily designed for use in the home.

In addition to protecting the product against mechanical damage, leakage, desiccation, and excessive oxidation, a suitable package must be easy to fabricate, fill, and close in a production line, and also be easy to stack, handle, and open. Moreover, a package should be inexpensive, easily obtainable, have qualities for rapid freezing, and be easy to label.

Tin cans with slip-over lids, glass jars, rigid plastic cartons, aluminum dishes, heavily paraffined canisters, and some types of transparent plastic bags, may be reused for frozen food or for other purposes.

Flexible sheets of aluminum foil, cellophane, Saran, polyethylene, pliofilm, and fibers of many kinds have certain cheracteristics desirable for frozen food packages. Laminating two or more of these sheets together or to rigid boards, has resulted in packages of superior qualities.

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Time-Temperature-Concentration Relationships for Heat Inactivation of Pectinesterase in Citrus Juices[a]

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Percentage inactivation of pectinesterase is presented for Valencia orange juices, pH 3.6 and 4.1, Pineapple orange juice, pH 3.9, and seedy grapefruit juice, pH 3.3, heated at concentrations of 1- to 4-fold to various temperatures from 125° F. (51.7° C.) to 210° F. (98.9° C.) with retention times in the pasteurizer of 12, 6, and 3 seconds.

The most desirable concentration of citrus juices prior to the application of heat is of principal interest in reducing the activity of pectinesterase. Heat treatment of citrus juices before concentration has been reported by the authors *(1)* and covers the inactivation of pectinesterase in citrus juices at sevral pH levels when retained in the pasteurizer for 12, 6, and 3 seconds. With increased acceptance of heat treatment by citrus processors, it has become desirable to heat at various levels of concentration. Inactivation data have been accumulated to cover the range of heating times, temperatures, and concentration of juices which will permit commercial operators to evaluate their current methods of heat treatment.

This investigation was concerned with the effect of temperature, retention time in the pasteurizer, and degree of concentration at which the juices are heated on the inactivation of pectinesterase in Valencia and Pineapple orange and seedy grapefruit juices.

EXPERIMENTAL PROCEDURE

The juices were prepared by extracting the juice, pulp, and seeds with moderate pressure using a Rotary press. The seeds were separated by a rotating reel and the juice finished in a Food Machinery, Model 35, finisher with an 0.030-in. perforated screen. The Valencia orange juices, pH 3.6 and 4.1, had corresponding pulp contents of 7.5 and 8% by volume. The Pineapple orange juice, pH 3.9, contained 8.5% pulp and the seedy grapefruit juice, pH 3.3, contained 6.5% pulp. The orange juices were concentrated to 42° Brix and the grapefruit juice to 38° Brix. Distilled water was added to obtain 1-, 2-, and 3-fold concentrates corresponding to 12°, 23°, and 33° Brix for orange and 10.5°, 20.5°, and 29.5° Brix for grapefruit. The concentrated juices were poured into 10-gallon containers and stored at —8° F. (—22.2° C.) until needed. Prior to heat treatment tests, the concentrates of 1- to 4-fold were rapidly thawed and warmed to room temperature with tap water.

For heat treatment the folded juices were pumped through a pasteurizer which contained three heating coils of ⅛-in. (internal diameter) stainless steel tubing. Steam heated water was circulated around the coils. The flow rate of the juice was adjusted in each tube to 560 ml. per minute. The juices were in contact with heat in the ⅛-in. tubes for 12, 6, and 3 seconds, the time required to raise the juices from room temperature to the desired temperature. All samples were cooled instantly by flashing under vacuum into small receptacles. Temperatures were controlled by a Brown potentiometer pyrometer and checked with a Bureau of Standards certified thermometer.

Methods of analyses were identical to those previously described *(3, 4)*, in which the pectinesterase method was essentially that of MacDonnell, Jansen, and Lineweaver *(2)*. Pectinesterase units represent the milliequivalents of ester hydrolyzed per minute per g. of soluble solids (° Brix).

RESULTS AND DISCUSSION

Effect of varying temperatures, and retention times in the pasteurizer on inactivation of pectinesterase in folded Valencia orange juices. Percent inactivation of the enzyme in Valencia orange juices pH 3.6 and 4.1, of different folds, containing 7.5 and 8% pulp, respectively, is presented in Tables 1 and 2. Temperatures to which the juices were subjected ranged from 125° F. (51.7° C.) to 210° F. (98.9° C.). Pectinesterase in the unheated Valencia orange juices, pH 3.6, varied from 0.0080 to 0.0094 units and for juices, pH 4.1, from 0.0100 to 0.0119 units.

Inactivation of pectinesterase in Valencia orange juices of 1- to 4-fold, pH 3.6 and 4.1, heated to 145° F.

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TABLE 1
Time-temperature relationships showing the percentage inactivation of pectinesterase in Valencia orange juices at varying concentrations, pH 3.6

Concentration		1-fold (12° Brix)			2-fold (23° Brix)			3-fold (33° Brix)			4-fold (42° Brix)		
Retention time sec.		12	6	3	12	6	3	12	6	3	12	6	3
Temperature		Inactivation			Inactivation			Inactivation			Inactivation		
°F.	°C.	%	%	%	%	%	%	%	%	%	%	%	%
125	51.7	22.4	17.5	11.9	23.0	18.1	14.9	19.0	16.5	10.6	15.6	13.0	9.2
135	57.2	51.4	27.4	16.9	40.3	34.0	26.2	44.8	27.6	21.6	24.5	23.7	16.4
145	62.8	84.7	70.2	54.4	77.0	73.2	58.7	82.4	68.1	54.2	73.9	58.9	52.2
155	68.3	89.1	87.4	84.9	84.2	82.9	81.8	88.7	86.9	84.9	86.5	85.1	83.0
165	73.9	90.0	89.2	87.5	88.9	87.4	85.9	90.9	88.8	87.9	91.9	88.7	87.7
175	79.4	91.7	90.2	89.2	93.0	90.0	88.9	93.8	91.1	90.1	94.4	93.4	92.3
185	85.0	94.3	91.8	90.2	96.0	93.0	91.4	97.2	94.0	92.2	96.5	95.5	94.4
190	87.8	97.6	94.2	93.5	98.5	96.1	94.5	99.0	97.2	95.1	97.8	96.5	95.5
195	90.6	100.0	97.6	96.0	100.0	98.5	97.1	100.0	98.9	97.2	100.0	98.9	98.0
200	93.3	.....	100.0	98.4	.....	100.0	98.5	.....	100.0	99.0	.....	100.0	98.9
205	96.1	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0

(62.8° C.) in 12, 6, and 3 seconds, indicated that longer retention times in the pasteurizer or a lower pH of the Valencia orange juices resulted in higher percentage inactivation of the enzyme. When Valencia orange juices, pH 3.6 and 4.1, at 1-, 2-, 3-, and 4-fold, were heated to temperatures of 125° F. (51.7° C.) to 155° F. (68.3° C.), there was a tendency to more inactivation of the enzyme at the lower fold.

Complete inactivation of the enzyme in 1- to 4-fold Valencia orange juices, pH 3.6, was obtained at 195° F. (90.6° C.) to 205° F. (96.1° C.) and in juices, pH 4.1, pectinesterase was inactivated at either 205° F. (96.1° C.) or 210° F. (98.9° C.).

Effect of varying temperatures and retention times in the pasteurizer on the inactivation of pectinesterase in Pineapple orange and seedy grapefruit juices of varied concentration. Pectinesterase activity of the unheated Pineapple orange juices, containing 8.5% pulp by volume, varied from 0.0099 to 0.0118 units; while the activity of the unheated seedy grapefruit juices with 6.5% pulp varied from 0.0048 to 0.0075 units.

Data on partial and complete inactivation of pectinesterase in Pineapple orange and seedy grapefruit juices are presented in Tables 3 and 4, respectively. Pineapple orange concentrates of 1- to 4-fold, pH 3.9, heated at temperatures of 125° F. (51.7° C.) to 145° F. (62.8° C.) showed appreciably more inactivation of pectinesterase was obtained at the lower concentration. Complete inactivation in the 1- to 4-fold Pineapple orange juices was obtained at 200° F. (93.3° C.) to 210° F. (98.9° C.).

The seedy grapfruit juices of 1- to 4-fold, showed no tendency toward higher enzyme inactivation in order of decreasing fold as was indicated in the concentrated orange juices. Complete inactivation of pectinesterase in the grapefruit juices was obtained at temperatures of 195° F. (90.6° C.) to 205° F. (96.1° C.).

SUMMARY

Relationships for heat inactivation of pectinesterase in Valencia and Pineapple orange and seedy grapefruit juices concentrated at 1- to 4-fold are presented. The percentage inactivation of pectinesterase in the concen-

TABLE 2

Time-temperature relationships showing the percentage inactivation of pectinesterase in Valencia orange juices at varying concentrations, pH 4.1

Concentration		1-fold (12° Brix)			2-fold (23° Brix)			3-fold (33° Brix)			4-fold (42° Brix)		
Retention time-sec.		12	6	3	12	6	3	12	6	3	12	6	3
Temperature		Inactivation			Inactivation			Inactivation			Inactivation		
°F.	°C.	%	%	%	%	%	%	%	%	%	%	%	%
125	51.7	8.4	3.1	0.0	10.1	4.4	0.8	11.6	4.3	2.1	13.5	7.7	5.4
135	57.2	20.5	11.3	6.1	16.2	9.6	5.6	15.0	11.4	5.8	16.5	10.5	7.9
145	62.8	37.2	16.5	12.5	24.9	13.0	11.6	27.5	14.0	13.5	27.3	13.2	11.6
155	68.3	48.1	30.4	23.1	39.0	28.8	22.8	46.7	26.3	24.0	34.7	20.9	18.0
165	73.9	77.2	60.5	52.1	79.6	59.1	52.2	85.8	64.6	52.7	81.7	59.8	55.0
175	79.4	90.3	85.1	79.3	92.4	89.3	82.1	93.6	87.8	86.6	93.7	89.8	83.8
185	85.0	94.8	92.3	89.1	95.2	94.6	91.3	95.6	92.9	92.2	95.5	90.7	89.4
190	87.8	96.8	94.9	92.4	96.2	95.8	94.5	97.9	95.1	94.4	97.3	92.6	92.0
195	90.6	98.1	95.5	93.6	98.0	97.8	96.9	99.0	96.3	95.5	98.3	95.4	94.8
200	93.3	98.7	98.1	96.0	99.0	98.8	97.7	99.1	98.9	96.5	99.1	97.2	96.4
205	96.1	100.0	100.0	98.9	100.0	100.0	98.8	100.0	100.0	98.9	100.0	99.1	98.4
210	98.9	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0	.....	100.0	100.0

TABLE 3

Time-temperature relationships showing the percentage inactivation of pectinesterase in Pineapple orange juices at varying concentrations, pH 3.9

Concentration		1-fold (12° Brix)			2-fold (23° Brix)			3-fold (33° Brix)			4-fold (42° Brix)		
Retention time-sec.		12	6	3	12	6	3	12	6	3	12	6	3
Temperature		Inactivation			Inactivation			Inactivation			Inactivation		
°F.	°C.	%	%	%	%	%	%	%	%	%	%	%	%
125	51.7	20.5	18.4	13.7	29.8	18.2	16.4	26.3	17.1	15.4	16.9	13.7	12.4
135	57.2	35.9	27.2	23.5	39.4	22.2	21.2	35.1	19.8	18.2	25.4	17.9	16.8
145	62.8	76.9	56.1	43.1	68.3	46.5	42.4	64.9	43.2	40.0	47.5	39.3	38.0
155	68.3	89.7	84.2	75.5	92.3	86.9	76.8	92.1	85.6	77.3	90.7	73.5	70.8
165	73.9	93.2	91.2	87.3	93.3	89.9	86.9	93.0	91.9	89.1	93.2	92.2	88.5
175	79.4	94.9	92.1	91.2	94.2	91.9	89.9	93.9	92.8	91.8	94.1	94.0	92.0
185	85.0	96.6	93.0	92.2	96.2	92.9	91.9	95.6	94.6	92.7	95.8	94.9	93.8
190	87.8	98.3	94.7	94.1	98.1	96.0	93.9	98.2	95.5	94.5	97.5	95.7	94.7
195	90.6	99.1	96.5	96.1	99.0	98.0	97.0	99.1	98.2	96.4	99.1	97.4	96.5
200	93.3	100.0	98.2	98.0	100.0	99.0	98.0	100.0	99.1	98.2	100.0	99.1	98.2
205	96.1	.....	100.0	99.0	.....	100.0	99.0	.....	100.0	99.1	.....	100.0	99.1
210	98.9	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0

TABLE 4

Time-temperature relationships showing the percentage inactivation of pectinesterase in seed grapefruit juices at varying concentrations, pH 3.3

Concentration		1-fold (10.5° Brix)			2-fold (20.5° Brix)			3-fold (29.5° Brix)			4-fold (38° Brix)		
Retention time-sec.		12	6	3	12	6	3	12	6	3	12	6	3
Temperature		Inactivation			Inactivation			Inactivation			Inactivation		
°F.	°C.	%	%	%	%	%	%	%	%	%	%	%	%
125	51.7	52.0	25.4	18.6	54.2	35.0	23.7	56.1	40.0	37.5	55.2	36.2	25.5
135	57.2	68.0	63.4	47.1	69.5	65.0	54.2	66.7	59.6	54.2	69.0	63.8	52.9
145	62.8	74.7	69.9	62.9	72.9	71.5	67.8	70.2	65.4	62.5	74.1	69.0	62.7
155	68.3	78.7	76.1	75.7	76.3	75.0	73.0	77.2	71.2	66.7	77.6	72.4	64.7
165	73.9	82.7	78.9	77.1	78.0	76.7	74.6	82.5	78.8	77.1	81.0	75.9	70.6
175	79.4	89.3	81.7	78.6	86.4	78.3	76.3	91.2	88.5	87.5	93.1	89.7	80.4
185	85.0	94.7	90.1	84.3	94.9	90.0	86.4	96.5	94.2	91.7	96.5	94.8	90.2
190	87.8	97.3	95.8	91.4	98.3	93.3	91.5	98.2	96.1	93.7	98.3	96.5	94.1
195	90.6	100.0	97.2	95.7	100.0	98.3	94.9	100.0	98.1	95.8	100.0	98.3	96.1
200	93.3	.....	100.0	97.1	.....	100.0	98.3	.....	100.0	97.9	.....	100.0	98.0
205	96.1	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0	.....	.....	100.0

trated juices increased when either the temperature of heat treatment or the retention time in the pasteurizer was increased. It was observed that where partial inactivation of the enzyme in the concentrated orange juices was desired, higher percentages of inactivation were obtained by heating at the lower concentrations, however, in the grapefruit concentrates this tendency was not exhibited. The degree of concentration of the juices did not change the thermal requirements for complete inactivation of pectinesterase.

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New Through-Flow Rotary Drier for the Partial Drying of Apple Slices

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A new type of through-flow rotary drier developed to dehydrate apple slices partially in preparation for dehydrofreezing is described. The drier has been used in a semi-commercial operation to produce 30,000 pounds of dehydrofrozen Newtown Pippin apple slices. Operating conditions are discussed.

In connection with work directed toward the commercial production of dehydrofrozen apple slices, a new type of through-flow rotary drier has been developed to meet the special needs of the process. Dehydrofreezing of apples consists essentially of partially drying sulfited apple slices to about 50% weight reduction, followed by packaging and freezing *(1)*. The process requires that the product be dried to a uniform moisture content, so that the slices will rehydrate uniformly to approximately their original moisture level when, for example, they are used as pie stock.

A second requirement, also a consequence of product quality, involves the amount of mechanical damage inflicted on the slices during drying. Quite obviously, the greater the damage, the less desirable the drying method.

The drying operation is complicated by the problem of controlling the sulfite content of the product. Sulfite concentration must be high initially to prevent the slices from darkening while drying, but must be reduced in the final product to a level barely detectable by the average consumer. Drying conditions therefore must promote the penetration of sulfur dioxide from the surface into the center of the piece, but at the same time allow the final product to retain not more than 100, and preferably about 50 p.p.m., of SO_2.

An experimental drier designed to accomplish these objectives is shown in Figures 1 and 2. It consists essentially of a rotating perforated sheet-metal drum, with air delivered up through the bed of material in the drum via four separate but adjacent air-duct compartments located longitudinally along the bottom part of the drier. Separate blowers and steam-air heating coils supply drying air at the proper temperature to the four heating zones. All or part of the air can be recirculated by adjusting the discharge and recirculating dampers. The material enters the drier at one end and is discharged continuously at the opposite end.

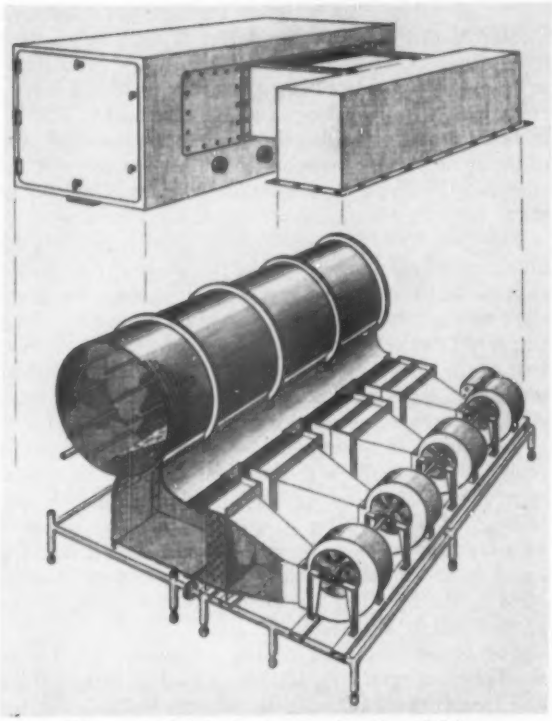

Figure 1. Sketch showing construction of drier.

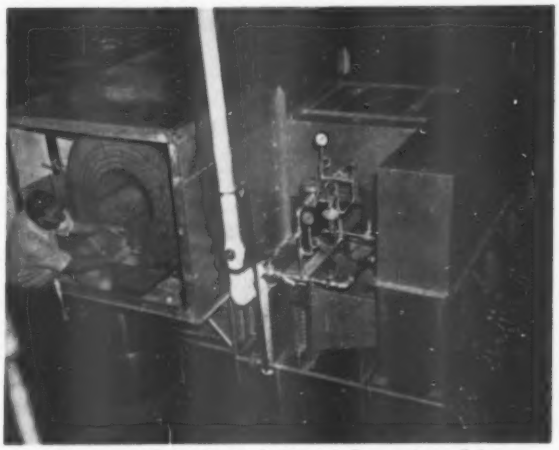

Figure 2. Experimental through-flow rotary drier.

CONTROL OF ADHERENCE OF SLICES

Earlier work with a different type of rotary drier had uncovered several problems peculiar to the drying of a material such as apple slices in a rotary drier. One of these problems involves the tendency of the fresh slices to adhere to any flat surface. This problem was so pronounced in the earlier drier that within 2 hours' operation, at least 75% of the drum interior was thoroughly coated with apple slices that had stuck and dried on the flat metal surfaces. Product quality is adversely affected when some of the adhering pieces, after being over-dried, fall off and are mixed in with the rest of the material in the drier. Not only product quality, but also drier performance is affected by the adhering slices. Drying capacity rapidly decreases as the slices progressively plug up the air passages in the drier drum; when all, or nearly all, of the passages are blocked off it drops off completely.

The solution to the problem is to increase the ratio of slice weight to contact surface. Since piece size and shape are fixed, the only way the ratio can be changed is to break up the flatness of the drum surface. This can be done in several ways. For example, the drum perforations can be dimpled inward, or protrusions such as round-head rivets can be attached to the drum at close enough intervals to prevent slices from lying flat on the surface. The solution adopted for the experimental drier, primarily for reasons of expdiency and minimum cost, consisted of a ¼-inch, 20-gage wire-mesh liner (Figure 3) push fitted into the drier drum in four longitudinal sections.

MIXING ACTION AND AIR MOVEMENT

Another problem in connection with the use of a rotary type drier for drying apple slices involves the mixing action required to insure uniform drying of the product. Earlier work had shown that the bed of material in the drier will slip and slide relative to the drum surface, instead of tumbling or mixing, especially at low drum speeds. Mixing action was better at higher speeds, but mechanical damage to the slices, due to abrasion between the slices and the drum surface as well as between slices, was noticeably increased.

The proper amount of mixing with no appreciable product damage was obtained by means of product lifters attached to the wire mesh drum liners, and a drum speed of one revolution every 4 minutes. The lifters (Figure 4) consist essentially of wood strips attached longitudinally to the wire mesh liners. The strips are 1-inch diameter half-rounds in 3 of the 4 liner sections, and wedge-shaped pieces 1½ inches high in the feed end section. Higher lifters are required at the feed end because the fresh wet slices are more slippery and therefore more difficult to agitate and tumble.

An important consideration in connection with through-flow driers is the air handling requirement. Because of the large volume of drying air that must be circulated, and the comparatively high air-flow resistance involved, fan size and power requirements must be considered with care. Prior to designing the experimental drier, tests were conducted to determine the air flow resistance or pressure drop in moderately deep beds of apple slices. The data indicated that the pressure drop through a stationary bed of apple slices 10 inches deep—the approximate bed depth for a practical commercial through-flow drier—would be about 3.9 inches of water (gage) standard air conditions, for an air-flow rate of 500 cubic feet per minute per square foot of cross sectional area. The measured pressure drop indicated the use of rather large fans. Subsequently, however, it was found that the pressure drop through a bed of apple slices tumbling in a rotary drier is considerably less than it is through a stationary bed—1.5 inches as against 3.9 inches. The fact that the pressure drop is lower in the case of the tumbling bed is best explained by referring to Figure 5. The figures represent a stationary bed of apple slices, and a through-flow drier of equivalent air flow

Figure 3. Wire cloth liners in drier drum.

Figure 4. Product lifters attached to drum liners.

area measured at the entrance to the bed, and a maximum bed depth equal to the depth of the stationary bed. All other conditions being equal, the pressure drop through the bed of material in the drier will be less because the continuous tumbling action opens up the inter-spaces between the slices; the air flow spreads out over a larger cross-sectional area once it is past the entrance to the bed; and the average bed depth is considerably less than the maximum. The smaller resistance to air flow reduces both equipment and operating costs by permitting the use of smaller fans operating under more economical conditions.

TESTING UNDER SEMI-COMMERCIAL CONDITIONS

During the 1953 apple season, the experimental drier was installed in a commercial processing plant at Watsonville, California, for the production of dehydrofrozen Newtown Pippin apple slices. During the operation, approximately 100,000 pounds of whole, unpeeled apples were converted to 30,000 pounds of dehydrofrozen slices. The production was destined for bakeries operated by a large chain of food stores on the east coast.

Laboratory studies of sulfite retention by apple slices during drying indicated that low relative humidities and low piece temperatures favor sulfite retention. High-humidity drying conditions are therefore a requirement for producing a product with a minimum of SO_2.

Other studies by Talburt, Walker, and Powers *(2)* indicated that sulfited Newtown Pippin slices can be tray-dried at 180° F. dry-bulb temperature and 130° F. wet-bulb temperature without darkening, and with an acceptably low concentration of SO_2.

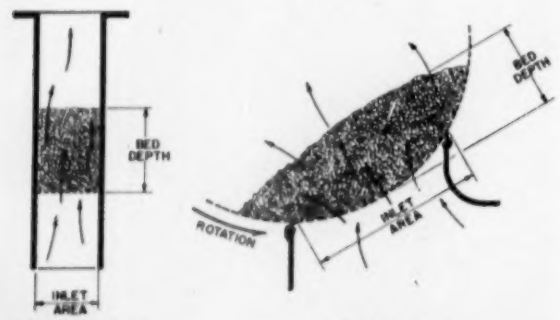

Figure 5. Air-flow in beds of apple slices.

The laboratory data helped to establish the conditions for initial operation of the rotary drier. Subsequent tests, however, showed that the laboratory results had to be modified for optimum performance of the drying equipment. Drying temperature was elevated to 200° F. in all 4 sections of the drier to increase the rate of drying of the product, and therefore the drying capacity of the equipment. Wet-bulb temperature was maintained at about 130° F. Maximum bed depth was 7 inches.

The comparatively high dry-bulb temperature and the lower relative humidity proved to be practical in the case of the through-flow rotary drier, because the slices were exposed to the hot dry incoming air only during the very brief periods of time that they were at the bottom of the drum. Most of the time the slices were exposed to the cooler, more humid air that prevails in the other parts of the product bed.

Enzymatic browning was inhibited by the sulfite treatment given the slices prior to drying. The treatment consisted of dipping the slices in a solution containing 3,000 p.p.m. of sulfur dioxide for about 3 minutes, followed by a holding period of one hour. The exact treatment was dictated by prevailing plant operating conditions. The slices contained 400 p.p.m. of SO_2 as they entered the drier.

The afore-mentioned drying conditions of 200° F. dry-bulb temperature, 130° F. wet-bulb temperature, and 7-inch maximum bed depth, resulted in a drying rate of approximately 400 pounds per hour, fresh-weight basis, for a drier with a drum 10 feet long by about 3 feet in diameter. The slices left the drier with about 80 p.p.m. of SO_2, or approximately 40 p.p.m. on a fresh-weight basis. The partially dried slices were firm in texture, natural creamy white in color, with no noticeable mechanical damage. Less than 1% (estimated) of the slices showed any signs of center browning, and this occurred mostly in the oversized pieces.

Both drying capacity and product quality were affected by changes in drying conditions. Higher dry-bulb temperatures, conditions that favor high piece temperatures, resulted in a product of softer texture. Higher dry-bulb and lower wet-bulb temperatures increased the drying capacity of the equipment but resulted in a product of undesirably high sulfur dioxide content.

A through-flow rotary drier of commercial size can be developed from the experimental unit largely by scale-up. Drying capacity, for example, can be increased by increasing the diameter and length of the drier drum. Air handling and heating capacities would, of course, have to be increased accordingly. A drier with a drum 60 inches in diameter by 20 feet long would have an estimated drying capacity of about 2,000 pounds per hour, fresh-weight basis. If greater capacity is required, driers installed in multiple are to be preferred because of the additional flexibility in plant operation that such an arrangement permits.

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Antibiotics as Aids in Fish Preservation. I. Studies on Fish Fillets and Shrimp[a]

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Effects of the antibiotics chlorotetracycline (Aureomycin), hydroxytetracycline (Terramycin) and Neomycin, and of the mixture of fumaric acid and sodium benzoate known as "Fran-Kem" on the storage life of fish fillets and of shrimp were studied. A definite preservative action was noted for chlorotetracycline and hydroxytetracycline in the order named after immersion of fish in a 2 p.p.m. solution; with Fran-Kem immersion in a 1000 p.p.m. solution some effect was noted but less than with either of the former. A similar treatment with a 2 p.p.m. Neomycin solution had no effect on the keeping quality of the fish or shellfish. The effects of the various substances were followed organoleptically and chemically, using the content of volatile reducing substances (VRS) and of volatile nitrogen compounds as indicators of the condition of the fish and shellfish. The VRS method was found to be more generally reliable than the determinations of either total volatile or of trimethylamine nitrogen.

Prevention of spoilage and the prolongation of the storage life of fish have been the subject of many investigations over a period of years. The effectiveness and safety of chemicals for this purpose have been limited and their use, therefore, has not become widespread. Probably one of the most useful of chemical preservatives, whose presence in fish is permissible, is sodium nitrite *(10)*.

In recent years interest has been taken in the possibility of preserving fish with antibiotics. Tarr and his associates *(1, 6-10)* in a series of studies have reported that, of a number of antibiotics tested, only chlorotetracycline and hydroxytetracycline have exerted any significant inhibitory action on fish spoilage, as judged organoleptically and by the increase in the direct bacterial counts. They also showed that when incorporated into ice and as dips these antibiotics were quite effective, as judged by the above criteria.

Studies have been initiated in this laboratory on the action of some of the more promising antibiotics on the keeping quality of fish under the conditions encountered locally and on the effects of such factors as concentration, temperature, species, and storage conditions on their effectiveness. In the present report are given the effects of chlorotetracycline, hydroxytetracycline and neomycin on the storage life of fillets of lingcod, black cod (sablefish), and sole and of raw whole shrimp at various storage temperatures above 0° C. (32° F.). These may be considered as of an orientative nature to determine the possible range of effectiveness of the antibiotics at relatively low concentrations for fatty and nonfatty fish and for shellfish. As a comparison, some results are also included for a chemical mixture, known as "Fran-Kem," for which preservative action on fish and shellfish has been claimed.

MATERIALS AND METHODS

Fish and shellfish. The fillets of lingcod *(Ophiodon elongatus)* had been stored at 0 to −5° C. for approximately 3 months. The fillets of black cod or sablefish (Anoplopoma fimbria) and of Dover sole (Microstomus pacificus) were commercial samples caught and filleted the previous day, and stored overnight in ice before being brought to the laboratory. The shrimp *(Pandalus sp.)* were caught in western Mexican waters and frozen in a 5-pound block. The blocks were well glazed when obtained. All frozen samples were thawed in air.

Antibiotics and chemical mixture. Chlorotetracycline as the hydrochloride, neomycin as the sulfate and hydroxytetracycline as the hydrochloride, were made up as 0.46%, 0.50% and 0.25% stock solutions in distilled water, respectively. Requisite volumes of the freshly prepared stock solutions were added to 5% sodium chloride solutions to give a final concentration of 2 p.p.m. or 0.0002%. The necessary weight of the powdered Fran-Kem was added to a 5% sodium chloride solution to give a working concentration of 1000 p.p.m., or 0.1%.

Tween 21. This is polyoxyethylene sorbitan monolaurate, a surface active agent.[b] The concentration used in the 5% sodium chloride solution was 0.1%. All the salt (sodium chloride) used in these experiments was the type known as "dairy salt," finely ground, containing some chemicals to prevent caking. Solutions of this salt are cloudy and not clear.

Fish treatments. The fillets and shrimp were immersed for the desired times in the salt solution, with or without any added preservatives, and stirred throughout the immersion. They were then drained and a number of fillets or shrimp for a sample were wrapped in parchment for subsequent storage. The lingcod and sablefish were stored in a container surrounded on all sides by a coarsely cracked ice-salt mixture, which was renewed periodically. The temperature inside the container in contact with the wrapped samples was noted at frequent intervals. The sole fillets and shrimp were stored in a household type refrigerator maintained at a temperature varying between 44° and 47° F., averaging 45° F.

Chemical evaluation of condition of fish. Two sets of tests were used to follow the state of the fish and shellfish samples, one for Volatile Reducing Substances (VRS) and one for total volatile and trimethylamine nitrogen. All tests were made on press juices of the fish obtained by manual or mechanical pressure. For the latter operation an adaptation of a household orange juice squeezer was found useful, but the cone of the juicer was replaced by two slightly convex circular perforated metal plates placed below and above the fish sample wrapped tightly in cheesecloth. All press juices were centrifuged and the clear aqueous portion as free as possible from any oil was used in the analyses.

The VRS were determined in 5 ml. of press juice in the apparatus described in a previous publication *(5)*. The 2 cubic feet of air used to aspirate within 40 minutes the volatile substances from the sample of press juice into the oxidizing reagent, 0.01N potassium permanganate in N sodium hydroxide solution, was freed from extraneous oxidizable material by passage in succession through two 2-liter portions of 1.5 N potassium permanganate in 2.5 N sodium hydroxide solution, followed by

[a] Based on a paper presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, June 27, 1954 at Los Angeles, California.

[b] Made by Atlas Powder Company.

two spray traps. The amount of reduction of the potassium permanganate was measured by adding, in the order named, 5 ml. of 6 N sulfuric acid, 3 ml. of 20% potassium iodide in 0.1% potassium carbonate solution and titrating the liberated iodine with approximately 0.02 N sodium thiosulfate in 0.2% sodium carbonate—0.1% sodium borate solution, using 5 drops of 1% soluble starch solution as inside indicator. Some work has been carried out with the view to replacing the titrimetric method with a spectrophotometric procedure. Furthermore, a modification of the apparatus is also being developed, in which a small circulating pump in a closed system is used to force the VRS from the press juice into the oxidizing reagent. With this latter set-up, the laboratory air-purification train will be eliminated and the apparatus will be more portable. These newer developments will be described in subsequent reports.

The volatile nitrogen determinations were carried out with the micro-diffusion technique of Conway *(2)*. The total volatile nitrogen in 1 ml. of press juice was liberated by 2 ml. of saturated potassium carbonate solution in the outer well of the unit and was trapped by 1 ml. of 2% boric acid containing the indicator mixture (10 ml. per l. of bromocresol green, 0.033% and methyl red, 0.066% in 95% ethanol) in the inner well of the unit. The trimethylamine nitrogen in 1 ml. of press juice was measured by adding 0.7 ml. of neutralized formalin solution followed by 2 ml. of saturated potassium carbonate solution to the mixed contents of the outer well. As before, the liberated volatile nitrogen was trapped in 1 ml. of the boric acid solution. The volatile nitrogenous bases in the boric acid solution were titrated with about 0.02 N sulfuric acid solution.

RESULTS AND DISCUSSION

It will be seen (Table 1) that of the 3 antibiotics tried, chlorotetracycline was most effective in prolonging the keeping quality of the various fillets, with hydroxytetracycline almost as effective. Neomycin did not exert any inhibitory effect under the conditions tried; the treated fillets spoiled as rapidly as those dipped in brine alone. From the limited data accumulated to date the effect of storage temperature on the effectiveness of the antibiotics cannot be definitely delineated. Furthermore, the results are complicated by the species and composition differences; the sablefish is a much fatter fish than either the lingcod or the sole, and hence conceivably can react somewhat differently from the leaner varieties. This may be a contributing factor in the differences in keeping quality found between the black cod or sablefish fillets stored at 2.8° C. (37° F.) and the sole fillets stored at 7.2° C. (45° F.). Another factor which may have contributed to this variation is the presence of the surface-active agent, Tween 21, in the dipping solutions used for the sole experiment. As stated previously, a survey of the general efficacy of antibiotics for diverse types of fish was the purpose of these experiments. The various factors will be studied in more detail in later experiments.

TABLE 1

Storage of Lingcod fillets at 9.4° C. (48.9° F.) after a minute dip in 5% brine and in 5% brines containing 2 p.p.m. of Chlorotetracycline and Neomycin

Days stored	Brine			Brine and chlorotetracycline			Brine and neomycin		
	VRS[1]	TVN[2]	TMN[3]	VRS	TVN	TMN	VRS	TVN	TMN
0	10.0	7.4	0	10.0	6.8	0	10.0	8.0	0
0.79	11.4	10.5	0	9.6	6.8	0	10.0	8.0	0
2.0	9.6	11.1	2.5	7.9	8.0	0	13.6	8.6	0.2
2.77	20.0	32.1	20.9	8.8	12.0	0.3	27.0	27.7	16.0
3.15	28.1	49.5	35.8	13.8	35.1	1.2	36.3	43.5	31.1
3.79	31.0	29.5	24.0	34.4	19.0	6.2	38.8	119.5	76.0
4.88	28.5	25.4	18.5	29.4	35.3	25.3	35.0	61.0	22.0

[1] Volatile reducing substances as microequivalents reduction per 5 ml. of press juice.
[2] Total volatile nitrogen as mg. per 100 ml. of press juice.
[3] Trimethylamine nitrogen as mg. per 100 ml. of press juice.
The fillets were judged spoiled after storage at 2.77, 3.79 and 2.77 days respectively.

TABLE 3

Storage of sole fillets at 7.2° C. (45° F.) after a minute dip in 5% brine containing 0.1% Tween 21 with and without 2 p.p.m. of Chlorotetracycline

Days stored[1]	Brine			Brine and chlorotetracycline		
	VRS	TVN	TMN	VRS	TVN	TMN
0	10.4	0	0	8.4	0	0
2.04	10.4	0	0	10.1	0	0
3.0	7.4	0	....	....	0	....
6.0	14.2	4.6	1.2	8.8	1.2	0
7.0	17.9	29.5	8.6	6.6	0	0
8.0	....	....	....	10.8	6.2	2.2
10.0	....	....	....	9.3	4.6	2.8

[1] The fillets dipped in brine were spoiled after 7 days, whereas those dipped in chlorotetracycline were judged still passable after 10 days.

In Table 4 are shown the results of a storage experiment on whole raw shrimp. In contrast to the results with fish fillets, neither chlorotetracycline nor any of the other substances prolonged the storage life of the shrimp at 7.6° C. (45.6° F.) as judged organoleptically or by the VRS values. The development of volatile nitrogen compounds in the shrimp was markedly less than in the fish fillets. However, even though the chlorotetracycline-treated shrimp were judged to be unfit for use after the same storage period as the others, their general appearance was apparently better; they were less slimy, less black discolored and somewhat firmer than the others in the experiment.

Compared to the action of the antibiotics, the mixture of fumaric acid and sodium benzoate called Fran-Kem is less effective than either chlorotetracycline or hydoxy-

TABLE 2

Storage of black cod (sablefish) fillets at 2.8° C. (37° F.) after a minute dip in 5% brine and in 5% brine containing 2 p.p.m. of chlorotetracycline, neomycin, hydroxytetracycline and 1000 p.p.m. of fran-kem

Days stored[1]	Brine			Brine and chlorotetracycline			Brine and neomycin			Brine and hydroxytetracycline			Brine and fran-kem		
	VRS	TVN	TMN	VRS	TVN	TMN	VRS	TVN	TMN	VRS	TVN	TMN	VRS	TVN	TMN
0	11.2	5.8	0	11.2	5.8	0	11.2	5.8	0	11.2	5.8	0	11.2	5.8	0
1.0	8.4	5.0	0	7.6	3.1	0	14.8	3.1	0	12.9	2.8	0	15.7	2.2	0
2.1	6.9	4.3	0	9.6	2.5	0	7.9	3.7	0	9.1	2.5	0	9.8	3.1	0
4.04	7.4	4.3	0.2	7.6	1.5	0	7.4	4.6	0.1	6.7	4.0	0	10.6	3.7	0
6.13	29.0	27.7	24.6	9.9	6.8	1.9	23.1	26.5	21.0	10.0	3.7	0.3	11.4	5.6	0.2
6.95	29.0	16.4	13.0	6.8	6.2	0.3	19.8	18.5	14.7	9.8	8.3	5.0	12.4	15.4	0.4
7.95	20.7	5.9	4.3	9.7	6.2	1.2	31.0	38.0	19.8	8.8	5.0	3.7	22.6	8.7	6.8
9.13	....	....	....	15.5	14.2	8.4	32.0	32.0	11.7	30.8	26.0	12.4	30.0	11.1	7.4

[1] The brine—, neomycin—, hydroxytetracycline—, and fran-kem-treated fillets were judged definitely spoiled after storage for 6.13, 6.13, 9.13 and 7.95 days, respectively. The chlorotetracycline-treated ones were judged still passable after 9.13 days.

TABLE 4

Storage of raw whole shrimp at 7.6° C. (45.6° F.) after a two-minute dip in 5% brine and in 5% brines containing 2 p.p.m. of Chlorotetracycline and 1000 p.p.m. of Fran-Kem

Days stored [1]	Brine			Brine and chlorotetracycline			Brine and fran-kem		
	VRS	TVN	TMN	VRS	TVN	TMN	VRS	TVN	TMN
0	6.1	0	0	6.1	0	0	6.1	0	0
1.08	7.8	0.3	0	8.7	2.5	0	11.3	0	0
3.0	7.9	0.3	0	5.7	0.5	0	11.3	0.5	0
5.16	16.4	5.9	0	11.3	3.1	0	17.3	5.9	0
6.0	10.5	4.3	0	14.9	6.2	2.5	9.3	6.8	0
7.0	26.6	8.7	0.9	30.9	12.0	1.8	21.4	3.7	0.2
8.1	31.0	16.6	2.2	29.2	14.2	1.9	27.0	12.9	3.7
9.0	17.0	7.4	0.3	23.0	10.8	2.5	24.0	13.6	1.5

[1] All the samples were judged spoiled after storage for 7 days.

tetracycline, but more than neomycin under the present experimental conditions. For example, the hydroxytetracycline-treated black cod or sablefish fillets were last judged passable after 7.95 days' storage at 2.8° C. (37° F.), whereas those treated with Fran-Kem were last judged passable after 6.95 days' storage. Compared to the control brine-treated fillets, the Fran-Kem treatment prolonged the sablefish fillets' keeping quality by almost 3 days.

From the above data the efficacy of the VRS method as a reliable index of the condition of fish fillets and of shrimp is definitely evident. For the 3 types of fillets the results for the VRS are paralleled fairly closely by those for both the total volatile and trimethylamine nitrogen. However, in the case of the shrimp, this relationship breaks down, since the VRS values showed a much greater and steadier rise than did the volatile nitrogen values, particularly those for trimethylamine nitrogen. In all other cases, the trend of the trimethylamine nitrogen values quite closely followed that for the total volatile nitrogen, whereas in the case of the shrimp this relationship was not evident. This may be regarded as a further indication that the production of trimethylamine is not a general property of all spoilage bacteria. Tarr *(10)* in this recent review discussed the role of trimethylamine in spoilage and of the bacteria producing it and further pointed out the limitation of trimethylamine as a generally reliable index of spoilage. Even though the content of volatile nitrogen compounds mainly depends on the type of spoilage bacteria present, as long as any spoilage does occur, with the concomitant production of odorous products, this is apparently accompanied by the production of VRS capable of reacting with the alkaline potassium permanganate reagent. This is also a consequence of the fact that the VRS method does not depend on the presence of any one type of substance but will pick up a wide diversity of volatile compounds.

SUMMARY

The main purpose of this series of experiments was to ascertain whether or not antibiotics had any preservative action on fish and shellfish in minimal concentrations, such as 2 p.p.m. As a start, fish fillets were used, including examples of thick, relatively non-fatty ones such as lingcod; thin, non-fatty ones such as sole; and fatty fillets such as black cod or sablefish, and shrimp, as an example of shellfish. It was found that chlorotetracycline and hydroxytetracycline had a definite preservative effect on the fish fillets in the order named, but none for the shrimp at the concentration used. Neomycin was not effective in prolonging the storage period of either fish fillets or shrimp. The mixture of fumaric acid and sodium benzoate known as Fran-Kem had some preservative effect for the fish fillets, although less than either of the above tetracycline derivatives, and also none for the shrimp under the present conditions.

Additional evidence for the efficacy of the VRS method as an index of the state of preservation of fish and shellfish is presented, in contrast to the variable significance of the content of either the total volatile or the trimethylamine nitrogen for this purpose. Other examples of this have already been published *(3, 4)*.

The antibiotics offer some hope of being a means to prolong the storage life of fish at relatively low concentrations. Further work, however, is needed, and it is being undertaken.

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The Relation of Tenderness to Protein Alterations During Post Mortem Aging[a]

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Tenderness in meat involves the physical, physiological and biochemical properties of skeletal muscle; yet an understanding of the fundamental nature of tender meat does not exist. Muscle consists of elongated cells, containing jelly-like protoplasm supported by a framework of connective tissue. Since in the raw state the more fibrous of these structures is the connective tissue, early investigations on meat were concerned with the relationship of this tissue to tenderness. Although it is quite understandable that a large quantity of connective tissue will affect tenderness, evidence which has been presented in recent years *(4, 5, 6, 11, 12, 16, 17, 19, 26)* indicates that increases in tenderness with post mortem age involve changes in the muscle plasma more than in the connective tissue. The study to be described here relates primarily to the investigation of muscle plasma in relation to tenderness.

Intracellular muscle constituents are largely protein and serve physiologically the functions of contraction and relaxation. The biochemistry and physiology of muscle is being investigated intensively in many laboratories and many findings which shed light on the nature of the normally functioning muscle may also be applicable to studies on the nature of tenderness and other quality attributes in meat. Much of the pioneering work in this field has been done by A. Szent-Gyorgyi, H. H. Weber and M. Dubuisson and their coworkers and each *(20, 21, 22, 7)* has made recent significant reviews of this field.

In the present instance perhaps the muscle plasma proteins of greatest interest are myosin, actin and actomyosin which account for about half of the muscle proteins and are usually considered of primary importance in contraction. Other proteins of muscle plasma are myoalbumin, myoglobulin and the chromoprotein myoglobin which accounts for the color of meat. These are perhaps the more important of the remaining proteins as far as meat is concerned, yet other proteins have recently been recognized *(7, 21, 22)*.

From the time of death muscle plasma goes through a series of characteristic changes. There is rigor mortis, a condition of rigidity or contracture which develops in a matter of hours after death but the time for rigor is variable. According to Szent-Gyorgyi *(21)* resting muscle is extensible because myosin is dissociated from actin. When the muscle dies, potassium ions by diffusion and adenosine triphosphate by enzymatic breakdown are removed from myosin. Actin then combines with myosin to form actomyosin which is quite inextensible and confers on the muscle the rigid condition of rigor mortis. Bate Smith *(1)* points out that other changes take place also shortly after death and these are the disappearance of adenosine triphosphate and glycogen and the appearance of lacttic acid and inorganic phosphate. These phenomena have been observed many times and are usually manifested by a gradual drop of the pH of muscle from about 7.3-7.4 in the living animal to about 5.4-5.6 within 48 hours post mortem. These changes are a reflection of the fact that the metabolism of muscle is changing from an aerobic to an anaerobic pattern.

After rigor mortis there is a gradual softening of the muscle. This resolution of rigor covers a period of days and appears to vary with temperature. At the same time improvement of tenderness of meat develops and the rate of tenderization is also dependent on temperatures *(4, 5, 6, 23)* of holding or ripening. Yet it should be pointed out that Ramsbottom and Strandine *(17)* showed that beef taken immediately at slaughter and before rigor mortis had set in was more tender than beef in rigor mortis. This phenomenon has also been observed by others. All of these facts suggest that the changes in the muscle plasma are directly associated with tenderness.

It has been rather widely held that the ripening process was proteolytic. Cathepsin has been suggested as the enzyme involved *(18)*. Yet classical approaches to get evidence bearing on this has yielded negative or at best inconclusive results *(11, 12, 14)*. Whatever the protein changes may be they are quite subtle. Prudent has suggested *(16)* and later Winegarden *et al. (26)* confirmed that there are no post mortem changes in connective tissue. Some information to be reported here tends to support this view.

This evidence at hand has led to a consideration of the possibility that protein fractionation studies might yield information on the nature of tenderness changes during post mortem aging and at the same time give some insight into why individual carcasses differ in tenderness and also why the meat from different animals displays different water binding properties as reflected in shrinkage on cooking, etc. (For example, steer meat *versus* bull meat). Furthermore, the fact that healthy skeletal muscle is rather constant in total nitrogen with respect to water, also suggests protein fractionation as an approach to the study of quality attributes of meat such as tenderness.

The work to be reported here is rather exploratory; yet some very interesting relationships were found which appear to indicate a direct relationship between the muscle plasma and tenderness. To be sure more questions are opened than are answered, but the results may

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

shed useful light on many theoretical and practical aspects of meat quality. Furthermore, this study illustrates the kind of fundamental information obtainable from an integrated research program wherein research on livestock production involving management and nutrition, and meats research from the marketing and biochemical points of view are brought together for the common goal of producing more and better meat cheaper. Thus, producer and consumer interests are held together.

BASIS FOR EXTRACTION

Since actin and myosin react to give actomyosin reversibly during contraction and relaxation and since actomyosin is the protein which gives rise to rigor mortis it was decided to study these proteins by determining, if possible, the amount of actomyosin in meat. Practically all work on muscle has been done from the physiological and biochemical consideration of trying to study normal functioning muscle. Meat is not normal muscle and particularly this is true with respect to pH which profoundly affects protein solubilities, denaturation, etc. A scheme was sought whereby meat could be fractionated at pH 5.6 in such a manner as to separate for the most part actomyosin from other proteins. Such separations are based on solubilities and have been summarized by Weber and Fortzehl *(22)*. Actomyosin is the least soluble of the proteins of muscle plasma. At neutral pH it starts to dissolve when myosin reaches its maximum solubility at ionic strength 0.3 (KCl). At lower pH solubilities move into the range of higher ionic strength. According to Hamoir *(9)* actomyosin is not extracted at pH 5 to 6 at 0.5 ionic strength.

Following a series of exploratory experiments based on the foregoing considerations a potassium citrate buffer of pH 5.6 and 0.48 ionic strength containing 0.22 M KCl was selected for this study. The pH is approximately that of the meat when tenderness was determined. It is assumed that the buffer causes no dissociation of actomyosin; such dissociation may be brought about using potassium iodide, pyrophosphate *(7)* or urea *(2)* at appropriate concentrations.

ANIMALS STUDIED

The animals used in these studies were taken from an extensive study of several years duration on the relation of castration to the efficiency of feed utilization, yield of meat, and quality of edible meat. Much of the information on the whole project will appear elsewhere. The animals used here were from the 1952-1953 study, and consisted of 48 Herefords born during April and early May 1952 from a single herd; and, when slaughtered most of them weighed approximately 900 lbs. and were around 13-15 months old. Eight (A) were castrated October 16, 1952, 5 (B) were castrated January 29, 1953, 10 bulls (C) were killed at light weight (approximately 800 lbs.), 10 bulls (D) were slaughtered at regular weights, 10 bulls (E) were implanted once with diethylstilbestrol on January 29, 1953 and 5 (F) were implanted twice with the hormone, once on October 22, 1952 and once on January 29, 1953.

Some additional data as noted are drawn from the previous years' study involving steers and bulls, and from investigations on processing of meat by infusion.

METHODS

Except as outlined below the data presented here were obtained by the methods and sampling techniques previously reported from these laboratories *(6, 10, 11, 12, 23, 24)*.

Hydroxyproline. Since connective tissue is uniquely high in this amino acid, hydroxyproline was determined as an index of connective tissue in meat. The method was a modification of the procedure of Newman and Logan *(15)* and will appear elsewhere *(25)*. The factor used to convert hydroxyproline to connective tissue was 8.07.

Protein fractionation. The extracting solution was designed to dissolve actin and myosin and other proteins but not to extract actomyosin. The extracting buffer was prepared essentially as reported by Sorensen *(3)* except that the potassium ion replaced sodium. Solution A consisted of 21.008 g. citric acid $C_6H_8O_7 \cdot H_2O$) and 200 ml. 1.00 N potassium hydroxide made to 1 liter with 0.4 M potassium chloride. Solution B was 0.1 N KOH. Sixty-nine ml. of solution A were mixed with 31 ml. of solution B to give a buffer of pH 5.60 ± 0.05, ionic strength 0.48 and 0.22 M potassium chloride.

Twenty grams of ground beef [samples obtained as reported by Husaini *et al. (11, 12)*] and 80 ml. of buffer were blended for exactly 3 minutes in a Waring blender, let stand for 5 minutes and blended again for 1 minute. During the blending the temperature increased 10-15° and after each blending operation it was necessary to immerse the blender bowl in tap water. It was also essential that the blender be maintained in excellent working order. The suspension was filtered through a Buchner funnel using glass wool to retain stroma proteins. The filtrate was centrifuged for 30 minutes at room temperature using an Adams Safeguard centrifuge at speed setting 3.5.

Two ml. of the extract were used to determine its nitrogen content by micro-Kjeldahl technique. The percent of nitrogen extracted was computed in terms of the total nitrogen in the meat itself which was determined by macro Kjeldahl procedures.

Relative viscosity of the extract. Five ml. of the extract at 30° C. was carefully pipetted into the large bulb of an Ostwald viscosimeter immersed in a 30° C. water bath. After 5 minutes, following the usual procedure, the time necessary for the extract to reach the lower miniscus of the small bulb was determined using a stop watch. The same procedure was done with the buffer as control.

Specific gravity. The specific gravity of each extract was determined using a Westphal balance.

Refractive index. An Abbé refractometer was used at 30° C. to determine the refractive index of each extract.

All determinations were done in duplicate or triplicate and values recorded as the respective means.

RESULTS AND DISCUSSION

During the course of the 3 years' study on castration it was possible to gather evidence bearing on whether or not changes in connective tissue contributed to the post mortem improvement of tenderness in meat. Thirty steers and bulls on the 1950-51 experiment were studied as to connective tissue [the alkali insoluble proteins of Husaini *et al. (11, 12)*] both at 3 and 15 days post mortem. It seems reasonable to expect that if the connective tissue were to break down during the aging period at least some solubility changes should take place. However, none were observed. This same series of cattle was examined for hydroxyproline; no change occurred in this amino acid. Nevertheless, the tenderness increased in all 3 groups.

TABLE 1

Post mortem changes in tenderness, alkali insoluble protein, and hydroxyproline

	10 Steers Castrated 5-11-50		10 Steers Castrated 10-31-50		10 Bulls	
Days Post Mortem	3	15	3	15	3	15
% Alkali Insoluble Protein	0.204	0.193	0.250	0.269	0.409	0.460
St. Deviation	.056	.067	.067	.072	.148	.093
St. Error	.015	.021	.021	.025	.050	.030
% Hydroxyproline	0.0445	0.0458	0.0507	0.0499	0.0546	0.0554
St. Deviation	.0051	.0065	.0048	.0036	.0069	.0060
St. Error	.0016	.0020	.0016	.0012	.0022	.0019
Tenderness	7.29	8.11	6.52	7.62	5.58	7.57
St. Deviation	.78	.49	.59	.87	.90	.66
St. Error	.25	.16	.19	.28	.29	.21

These data clearly indicate also that determination of alkali insoluble proteins is less accurate than hydroxyproline determinations for connective tissue. Even so, it appears that the suggestions of Prudent *(16)* and Winegarden *(26)* are substantiated.

The main body of data pertinent to the subject at hand is given in Table 2. Some significant differences will be noted between the groups on tenderness, hydroxyproline and extractable nitrogen, but the groups are rather small for comparison. Consequently, discussion concerning different treatments will be reserved for a later paper covering the more extensive castration study. It is sufficient to note here that the meat from the bulls of both light and medium weights and that from doubly implanted bulls compared very favorably with the castrates on tenderness and general acceptability of the meat. This is also confirmed by some of the data found in Table 1. The single implants had dissipated, and these bulls showed striking and rapid changes in secondary sex character as slaughter dates approached. Their carcasses were even more "bully" than the untreated males.

When all 48 animals are pooled and studied as a unit, it is quite apparent that all of these comparatively young animals did not show wide differences in tenderness and connective tissue as revealed by hydroxyproline values. It is seen that hydroxyproline values in the whole group seemingly bear no relation to tenderness. Hence, it appears that the uniformity of the group in this respect should accent any relation between muscle plasma and tenderness. Whereas hydroxyproline shows no relation to tenderness a very good correlation of extractable nitrogen with tenderness is obtained. (Correlation coefficient is 0.507; for 46 degrees of freedom, correlation at the 1% level is 0.370). To be sure, it is possible that this correlation is due to chance or due to a bias introduced by treatment or some other factor. However, inspection of the data does not seem to indicate an obvious bias by groups.

It should be pointed out that this was the first attempt at this type of approach and much needs to be done. It seems that more than actomyosin remained insoluble. It is known that some muscle proteins are easily denatured; just how much of the residue was denatured protein is unknown.

The proteins in the extract should contribute also to viscosity and refractive index of the extract. These properties of the extracts were determined for 24 out of the 48 carcasses with the interesting results summarized in Table 3.

These data were obtained since it was possible to get these physical constants while other information was being obtained. It seems that refractive index should get more careful attention These results were obtained only with an Abbé refractometer and it is possible that the correlation is not too reliable. However, a possible relation is indicated between tenderness and refractive index of the extract and this will be studied further in a more careful manner using a more accurate refractometer. The fact that refractive index showed a closer relationship than viscosity to both nitrogen in the extract and tenderness suggests something other than

TABLE 2

Tenderness, hydroxyproline content and total nitrogen extracted of the meat 15 days post mortem from steers castrated at different age, bulls, and bulls treated with diethylstilbestrol

Animal No.	Tenderness 15 Days	Hydroxyproline Wet Basis, %	% Total N Extracted
A. Steers castrated 10–16–52			
45	8.83	.0321	27.7
2	8.58	.0403	34.0
34	8.50	.0393	30.2
30	8.17	.0427	31.3
10	7.83	.0436	29.0
6	7.67	.0345	29.8
18	7.50	.0289	20.1
28	6.92	.0528	31.6
Mean	8.00	.0379	29.20
Standard Deviation	.64	.0067	4.15
Standard Error	.23	.0022	1.47
B. Steers castrated 1–29–53			
46	8.08	.0257	27.3
23	7.92	.0256	26.7
12	7.33	.0236	26.8
37	7.33	.0308	28.4
5	7.25	.0306	26.8
Mean	7.58	.0273	27.22
Standard Deviation	.39	.0032	.72
Standard Error	.17	.0015	.32
C. Bulls slaughtered at light weights			
48	8.08	.0364	21.7
26	7.92	.0276	23.3
35	7.67	.0383	32.0
13	7.33	.0286	26.1
11	7.25	.0285	24.4
1	6.92	.0353	23.4
49	6.67	.0246	20.5
38	6.50	.0230	21.1
22	6.33	.0330	26.4
50	6.09	.0252	20.7
Mean	7.09	.0301	23.98
Standard Deviation	.69	.0053	3.44
Standard Error	.22	.0017	1.09
D. Bulls slaughtered at regular weights			
14	8.25	.0357	29.0
25	8.10	.0443	27.6
36	8.00	.0314	27.8
17	7.67	.0438	26.8
7	7.67	.0519	21.3
20	7.67	.0436	24.8
16	7.50	.0333	25.5
9	6.75	.0550	21.6
33	6.58	.0435	21.6
27	6.42	.0550	19.9
Mean	7.45	.0438	25.29
Standard Deviation	.65	.0086	3.55
Standard Error	.21	.0027	1.12
E. Bulls implanted with diethylstilbestrol 1–29–53 [1]			
8	7.67	.0414	25.1
43	7.42	.0317	25.1
47	7.23	.0516	26.3
4	7.14	.0337	25.9
41	7.00	.0330	25.9
19	6.83	.0333	26.4
39	6.33	.0318	24.4
40	6.25	.0267	26.5
3	6.08	.0343	21.8
44	5.79	.0390	26.0
Mean	6.77	.0347	25.25
Standard Deviation	.62	.0069	1.52
Standard Error	.20	.0022	.48
F. Bulls implanted with diethylstilbestrol 10–22–52 and 1–29–53 [1]			
29	8.86	.0176	31.7
42	8.43	.0197	28.2
24	7.64	.0219	32.8
32	7.15	.0240	25.1
31	6.54	.0241	27.3
Mean	7.72	.0215	29.04
Standard Deviation	.94	.0027	3.16
Standard Error	.42	.0012	1.41
Grand Mean	7.37	.0344	26.25
Standard Deviation	.76	.0093	3.55
Standard Error	.11	.0014	.51
Correlation Coefficient with Tenderness:		−.082	+.507
Probability for 46 degrees of freedom:		.50	.01

[1] 25 mg./cwt.

TABLE 3
Summary of tenderness of meat, percent nitrogen extracted, refractive index and viscosity of extracts at 30° for 24 carcasses

	Tenderness 15 days	Mg. Nitrogen per ml. extract	Refractive Index	Viscosity
Mean	7.48	1.952	1.34008	1.1065
Standard Deviation	.84	.237	.00046	.0282
Standard Error	.17	.049	.00009	.0058
Correlation coefficient with nitrogen in extract			0.810	0.423
Probability (22 degrees of freedom)			0.01	0.05–0.02
Correlation coefficient with tenderness		0.468	0.565	0.316
Probability		0.05–0.02	0.01	0.20–0.10

proteins in the extract may be of importance in relation to tenderness.

If the amount of nitrogen extracted is related to tenderness, and if the post mortem improvement in tenderness is related to the muscle plasma more than to connective tissue it may well be that there should be some changes in extractability with post mortem age. Unfortunately it was only possible to study 14 animals to determine changes in extractability between 4 to 5 days and 15 days and only in 9 animals was tenderness determined at both times. The results which were obtained are shown in Table 4 and are too scanty to be definitive. To be sure, there were increases in both tenderness and nitrogen extracted from 4 to 15 days post mortem. There was considerable variation and one can hardly overlook the treatment factor in these data. These changes do indicate an increase in solubility of proteins in the extracting buffer for it has been observed *(11, 12)* that little or no increase in non-protein or proteose-peptone nitrogen occurs during this aging period. Precisely what is going on and the significance of these observations is not presently clear. It is possible that some differences and variations are artifacts. Consequently, these post mortem changes in extractability are being investigated further and will be reported at a later time.

A careful study of the data presented here readily provokes more speculation than conclusions. However, there seems to be no doubt that muscle plasma is intimately related to tenderness in meat. Yet the nature of this relation is far from clear. However, there is evidence to support two lines of thought. One is that initial toughening of meat at slaughter is due to the formation of the actomyosin complex from actin and myosin and that subsequent tenderization is the dissociation of actomyosin into actin and myosin. The second is that subsequent tenderization involves rather than extensive dissociation of actomyosin only a slight dissociation; this is coupled with or is brought about by a redistribution of the ionic atmosphere associated with the plasma proteins. In other words, post mortem tenderization may be a manifestation of the general problem of the relation of ions to protein hydration, which is so intimately associated with many food problems involving consumer quality attributes as well as shrinkage in cooking and processing.

TABLE 4
Changes in extractability of meat proteins with post mortem age

Cattle No.	Group	4-5 Days		15 Days	
		Tenderness	% Total N Extracted	Tenderness	% Total N Extracted
34	A	5.50	18.0	8.50	30.2
10	A	6.75	17.0	7.83	29.1
6	A	6.08	19.6	7.67	29.8
28	A	4.75	16.5	6.92	31.6
25	D	.....	21.5	8.10	27.6
7	D	.....	18.5	7.67	21.3
20	D	.....	15.0	7.67	24.8
9	D	.....	17.9	6.75	21.6
27	D	.....	19.9	6.42	28.6
8	E	7.00	24.8	7.42	25.1
47	E	4.25	24.6	7.23	26.3
4	E	5.92	23.9	7.17	25.9
41	E	4.75	25.6	7.00	25.9
44	E	4.50	25.4	5.79	26.0

In support of the first explanation are several bits of evidence. The increase in post mortem extractability comes to mind first for it does not seem necessary that improvement in tenderness should require complete dissociation of actomyosin. It may be that only a relatively small amount of dissociation is necessary to cause the necessary improvement in tenderness and dissociation beyond that point is of little consequence. Another bit of evidence is that A. Szent-Gyorgyi *(20)* has shown that the conversion of actomyosin to actin and myosin is accompanied by an increase in sulfhydril groups. McCarthy and King *(14)* have shown that this happens during post mortem aging. Kuschinsky and Turba *(13)* have shown that when actomyosin breaks down to actin and myosin a slight increase in pH results. In going over data accumulated in experiments over the past 3 years where both pH and tenderness were determined at 3 or 4 days and 15 days post mortem not a single instance of a decrease in pH was observed in 39 animals where such data were obtained. These increases in pH could not have been due to bacteria. In fact, there seemed to be a relation between increases in tenderness and pH but certainly at this point no direct relation could be postulated for the pH determinations are insufficiently accurate for reliance at the second decimal figure. In the 39 carcasses increases in tenderness averaged 1.51 with standard deviations and error of 0.89 and 0.14, respectively. The pH increases averaged 0.14 with standard deviations and error of 0.099 and 0.016, respectively.

The second point of view may be developed in light of the work of many in the field of biochemistry and physiology which indicates that the proteins and the ions in functioning muscle appear to be in a high state of organization. It may be that after the onset of rigor mortis random diffusion or redistribution of ions takes place for one reason or another changing the hydration of the muscle proteins and particularly actomyosin. Indeed protein hydration is intimately related to total ionic strength as well as to types of ions present. Such increase in hydration could account for increases in tenderness and also for the lack of more direct relation between increases of extractability of nitrogen and increases in tenderness. In Table 3 it is noted that in the 24 animals where refractive index, viscosity and extracted nitrogen data are available the best relation with tenderness at 15 days was obtained with the refrac-

tive indices of the extracts rather than their nitrogen contents or viscosities. It is also well to point out that for whatever reasons post mortem pH increases, this phenomenon would increase protein hydration and might account for some improvement in tenderness. But it seems doubtful that pH is the primary factor of increases in tenderness with post mortem age. In any event there is evidence that there may be a very close relationship of ionic atmosphere and tenderness.

In view of the foregoing remarks it may be worth recalling that sodium phosphates and other sodium salts have been used to promote tenderness and decrease shrinkage in shrimp *(8)* and for the past 8 years a classroom experiment has been conducted at this University to bring out just such relationships in red meats. Similar ionic-protein relationships are commonly practiced in milk processing where it has reached a high degree of development.

Experiments have been conducted in Ohio *(23, 24)* on infusion of animals at slaughter and before dressing out, and it was considered that this was an ideal technique to study the possible relationship between ionic atmosphere and meat quality. These studies are exploratory but there can be little doubt of the profound effect that can be produced by modifying the ionic atmosphere. It is beyond the scope of this paper to describe these experiments in detail but whole animals and hot rounds have been so treated. When animals were infused with 10% of their weight of 20% salt solution containing sodium nitrate and sodium nitrite, a delightful whole "corned" beef of remarkable tenderness was produced. Furthermore, this meat showed much improved water holding capacity on cooking and on freezing and thawing (practically no drip at all). Meat treated with 20% salt and 8% salt alone showed these properties to a greater or lesser degree . This was true even though percent nitrogen extracted showed no marked differences between matched treated and untreated rounds. These observations tend to lend credence to the idea that post mortem changes in muscle protein are in the nature of an ion-protein interaction.

The concept of proteolysis in post mortem tenderization has not been considered here except to point out that there is evidence that other factors are involved in increases in tenderness. It may well be that post mortem intramuscular changes are a combination of any or all three phenomena—proteolysis, dissociation of actomyosin, or ionic rearrangement to increase the degree of protein hydration.

SUMMARY

Connective tissue does not appear to contribute to increases in tenderness on post mortem aging inasmuch as total alkali insoluble protein does not change.

The percent of total nitrogen extractable by the buffer described herein is related to tenderness of meat at 15 days and indicates that muscle plasma plays a major role in tenderness of meat.

The index of refraction and viscosity of the extracts may be related to tenderness, but further work is needed to verify this relation.

Evidence is presented which suggests that increases in tenderness with post mortem age may be related to (a) the dissociation of actomyosin or some similar protein changes which increase protein extractability and (b) redistribution of ions within muscle thus causing increased hydration and tenderness.

Meat may be markedly modified in tenderness and behavior on cooking, freezing and thawing by changing the ionic atmosphere in muscle. Such changes may be brought about by infusing whole or parts of freshly killed animals.

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Influence of Storage Conditions on Drying and Discoloring of Beef

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The influence of air temperature, air speed and relative humidity on the rate of drying and discoloring of beef was investigated within the following ranges:

Air temperature.....34-50° F.
Air speed..... 0-100 ft. per min.
Relative humidity.....62-92%.

Samples weighed approximately 500 grams and were taken from both utility and choice grade carcasses. Storage time was extended to 72 hours in some cases but an exposure of 24 hours was observed to be sufficient for the evaluation of the influencing factors in most cases. The surface color was indicated by Munsell standards. A special photronic intensity meter was calibrated by Munsell standard colors and was used to determine the "Value" of the meat surface. Saturation and hue were indicated by visual comparison with Munsell standards; however, it was observed that these factors were of secondary importance only. Both color and weight data after exposure were expressed in terms of the ratio of the final to initial readings.

Meat progressively dries and darkens while kept in cold storage. Accordingly, refrigeration engineers need to know the effects of temperature, relative humidity, and air speed in order to design the optimum coil and air distribution system for cold storage rooms. Test results for beef samples subjected to various storage conditions are presented in this report. A detailed description of the test laboratory and photronic intensity meter used for this research has been presented *(1)*. Accordingly, only a brief discussion is presented subsequently.

The air temperature in the 11½ x 18 x 9½ ft. test room is controlled by a unit cooler equipped with an 8 row direct expansion finned coil. Humidity control is achieved by evaporation of water from an open vat by means of an electric immersion heater. Test meat samples were located within a wind tunnel contained in the cold storage room, and consequently, were subjected to the same temperature and humidity environment as the room. The quantity of air passing through the tunnel is regulated by a damper and measured by an orifice type meter.

The photronic intensity meter consists of four photoelectric cells connected in parallel and arranged to receive light reflected from a specimen surface covering a 3½ inch diameter aperture. A parallel light beam of known intensity is produced by a collimating lens from a 500-watt incandescent projector lamp source. Diffused light of diminished intensity is reflected by the surface of the specimen over the aperture with a representative fraction being intercepted by the photronic cells. By elimination of stray light, the flux density at the plane of the cells depends on the strength of the light source, area of the aperture, the distance between the photronic cells and the aperture, and reflectivity of the surface. Light intensity may be adjusted at any desired interval by use of a standard reflective specimen, a section of highly reflective movie screen.

The photronic cells were equipped with filters to produce a spectral sensitivity curve as nearly as possible coincident with that of the eye. The electric current corresponding to the intensity of the light received by the cells is measured by a precision microammeter. Standard Munsell color samples were employed to calibrate the instrument. The instrument was found to be sensitive to only one of the tristimuli of color; namely, value *(11)*. A visual comparison of color cards with meat samples by several observers revealed that the darkening of the surface could be satisfactorily defined in terms of value without the complete specification involving the other stimuli. Figures 1 and 2 depict the photronic intensity meter, and Figure 3 shows a plot of microammeter readings registered corresponding to the "value" of Munsell color cards.

PREVIOUS RESEARCH

Brooks *(5)* studied some of the factors in the formation of methemoglobin in the pigmented muscles of the foreleg of an ox in the absence or presence of oxygen. After standing a few hours at 0° C. a steady state was established such that the depth of oxygen penetration was about 2 mm., and after 100 hours the depth had increased linearly to about 4 mm. He attributed the increase in depth to a slow decrease in the oxygen consumption of the tissue. Freezing and thawing the tissue produced no significant effect on the oxygen uptake. Methemoglobin was slowly formed in the oxygen region of tissue exposed to air and most rapidly at some distance from the tissue-air interface. Freezing and thawing appeared to increase the rate of methemoglobin formation.

Brooks (Matilda M.) *(7)* showed that injection of glucose prevents the formation of methemoglobin in animals, or if methemoglobin is already present, it can by the same means be reduced to hemoglobin which is then readily oxygenated to oxyhemoglobin.

Figure 1. Photronic intensity meter and room cooling coil.

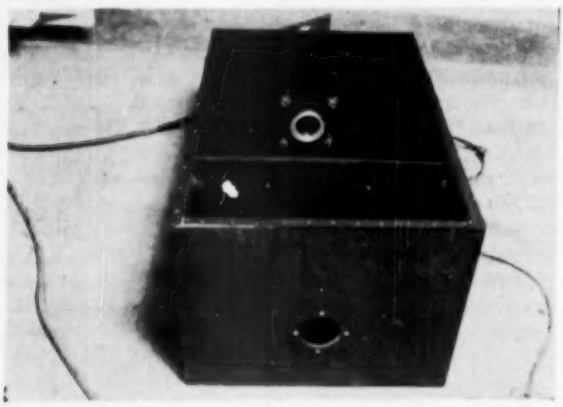

Figure 2. Photoelectric cells and lens of photronic intensity meter.

Brooks *(4, 6)* studied the rate of oxidation of ox-blood. In one set of experiments laked blood was kept at —20° C. and portions were thawed when required. The rate of oxidation of hemoglobin to methemoglobin in a phosphate buffer, at a pH of 5.69, was measured at 30° C. and at several different constant partial pressures of oxygen. He concluded that the formation of methemoglobin was the only detectable reaction; the rate of oxidation at different oxygen pressures was proportional to the concentration of reduced hemoglobin; and no evidence was obtained that the rate-determining step was selective reaction of oxygen with one or more of the intermediate compounds of oxygen and hemoglobin.

Mangel *(10)* used the method of measuring methemoglobin present in ground beef as a measure of deterioration. Palatability tests indicated that by the end of 32 weeks of storage, samples

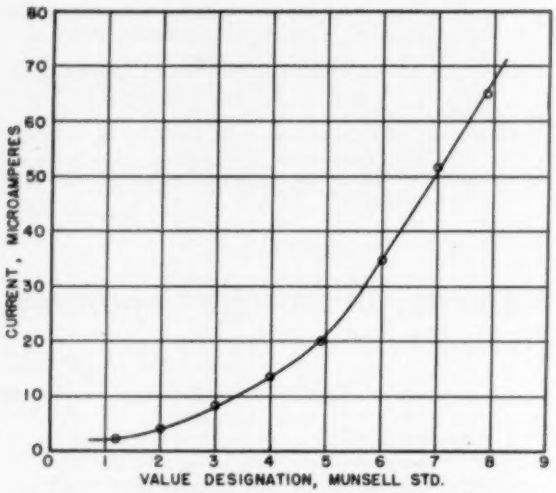

Figure 3. Calibration curve of photronic intensity meter relative to Munsell Standard colors.

kept at —24° C. were more desirable in appearance, odor, and flavor than those stored at higher or fluxating temperatures. The samples stored at —12° C. were considered undesirable in flavor and odor though not in appearance, while those fluxated for 4 months were considered undesirable in all 3 respects by the end of 32 weeks. This does not confirm the theory that change in color may be used as an indication of change in palatability.

Ramsbottom and Strandine *(12)* conducted research to obtain certain characteristics of beef at frequent intervals from 2 hours after slaughter to 12 days following slaughter. Beef carcasses were selected at the time of slaughter. Munsell color readings were made on the beef at frequent intervals during the first 2 days following slaughter. The readings were made on the cut surface one-half hour after cutting. Beef which was frozen 2 hours following slaughter was lighter in color in the frozen state and darker in the thawed state than beef which was chilled for 24 hours or more before freezing.

Haldane *(9)* showed that the color of uncooked cured meats is due to nitric oxide hemoglobin. The pigment is formed by the interaction of muscle-and blood hemoglobin in the tissue with nitrite derived from the saltpeter used in the curing.

Brooks *(3)* has pointed out that the action of nitrite on hemoglobin is the basis of color fixation on the curing of bacon. He has shown that the path of the reaction is determined by the oxygen concentration in the system and that the presence of oxygen has an important effect on the stability of bacon color.

Urbain and Jensen *(13)* have described a method of preparing pure nitric oxide hemoglobin by reaction of nitric oxide with hemoglobin. Over pH range 5 to 8, the spectrum of nitric oxide hemoglobin was shown to be constant. In the absence of oxygen nitric oxide hemoglobin is a stable compound, but it oxidizes easily by atmospheric oxygen. This oxidation is inhibited by an increase of pH and assisted by a rise in temperature.

Urbain and Greenwood *(14)* have described a technique of determining the concentration of hemoglobin in dilute solutions. They have shown that the color of meat in general is affected by the presence of microorganisms acting upon the sensitive heme pigments responsible for the color.

Greenwood, Lewis, Urbain, and Jensen *(8)* used oxyhemoglobin and nitric oxide hemoglobin to determine the role played by sugars in color development of cured meats. Their experiments suggest the following role of sugar in curing meats:

1. It aids, under certain equilibrium conditions, in improving the color of cured meat by helping to establish reducing conditions when nitric oxide reacts with hemoglobin to form nitric oxide hemoglobin, thus preventing oxidation of hemoglobin to methemoglobin.
2. It tends to prevent oxidation of ferro-hemoglobin derivatives to ferri-hemoglobin derivatives during storage following the curing process.

3. It helps to conserve meat during the curing by exerting a protein sparing action.

Their results obtained on isolated pigments have been duplicated under actual curing conditions with meats and have led to the same general conclusions. In the absence of microorganisms, sugars appear to exert no action on blood pigments or substances produced by them.

SCOPE

Tests reported in this paper were conducted with samples of beef weighing approximately 500 g. and cut about one inch thick. The samples were taken from choice and utility grade cuts. Samples from utility and choice cuts represent round and sirloin tip steaks, respectively. The choice grade carcasses had been subjected to a special tenderizing process; however, in all cases samples were cut to provide a fresh surface, and were selected to assure the best possible uniformity from one test to the other. The factors considered were the carcass storage time, storage environment, identity of cuts, surface freshness, and time lapse between cutting and reaching the test laboratory. At the test laboratory, prepared samples were clamped in wire hangers designed with a 3½ inch aperture to fit the photronic color intensity meter. The hangers are provided with hooks appropriate for hanging in the wind tunnel. The employment of the hangers minimizes handling of the samples and possible resulting contamination.

During the experimentation, test samples were studied within the dry bulb temperature range from approximately 35 to 50° F., an approximate relative humidity range from 60 to 90% and an air speed range from 0 to 100 feet per minute. Established test conditions were maintained constantly throughout the test period except for interruptions invoked by defrosting the coil of the unit cooler.

Two series of tests were conducted. The first series utilized 2 samples of utility grade meat, with one sample orientated so that the air impinged against the flat surface and the other so that the air flowed parallel to the flat surface. With this exception the pair was subjected to the same environment. Tests in this series had a duration from approximately 48 to 72 hours. The second series consisted of the simultaneous use of 5 similar samples all orientated so that the air passed parallel to the flat surface. These samples were from choice grade carcasses which had undergone a special tenderizing process. The purpose of using 5 similar samples was to enable determination of an average value of the data which was expected to compensate for the different behavior of apparently similar samples under identical storage environment. All tests of the second series had a duration of 24 hours.

EXPERIMENTAL RESULTS

Figure 4 exemplifies the results of the first series of tests. The ordinate represents a ratio of the weight of the sample at any time to the initial or the ratio of the microammeter readings of the photromic intensity meter at any time to the initial. The abscissa represents the time of operation. An observation of this representative curve reveals that the weight decreases almost linearly with time while the color (defined in terms of value) decreases rapidly at first and levels off after a few hours. Sample 1 was located so that the air impinged against the flat surface while for sample 2, the flow was parallel to the surface. The influence of surface orientation on color or weight was not of sufficient magnitude to be discerned by the tests. As to be expected, both the weight and color decrease with time.

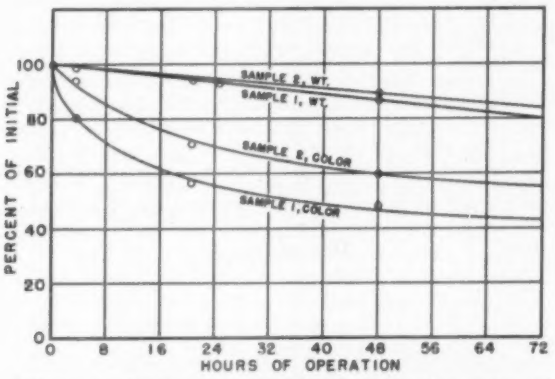

Figure 4. Typical desiccation and discoloration curves of beef samples. Particular storage environment: Air speed—75 ft. per min., dry bulb temperature—38.5° F., relative humidity —75%.

The ratio of both the weight and microammeter readings to the initial value for each sample of the first test series was analyzed after 24 hours of operation. Had a time lapse, from the initial of more than 24 hours been taken, the comparative results would have been approximately the same. Comparisons after a shorter period of operation is undesirable because of the initial rapid rate of color change as evidenced by Figure 4.

With air speeds ranging from 0 to 100 ft. per min. at relative humidities and dry bulb temperatures near 75% and 38° F., respectively, the ratio of the sample weight after an exposure of 24 hours to the initial may be expressed as

$$r_w = 0.935 - 0.042\ S \qquad (1)$$

where r_w is the ratio of initial to final weight and S is the air speed in ft./min.

Similarly the ratio of the microammeter readings is given by

$$r_c = 0.70 - 0.07\ S \qquad (1a)$$

With dry bulb temperatures ranging from 34 to 52° F. at air speeds, and relative humidities near 50 ft. per min. and 75% respectively, the ratio of the sample weight after an exposure of 24 hours to the initial may be expressed

$$r_w = 0.92 - .33\ (t - 34) \qquad (2)$$

where t is the dry bulb temperature.

Similarly the ratio of the microammeter reading is given by

$$r_c = 0.71 - .33\ (t - 34) \qquad (2a)$$

Data from the first series of tests were corrected to a dry bulb temperature of 38° F. and air speed of 50 ft. per min., and the ratios after 24 hours exposure to the initial were plotted, as depicted by Figure 5, as a function of relative humidity. Curves A and D represent the weight and color ratio, respectively, for the first series of tests. These lines are given by

$$r_w = 0.66 + .327\ RH \qquad (3)$$

and

$$r_c = 0.41 + .327\ RH \qquad (3a)$$

Curves B and C of Figure 4 represent the weight and color ratios for the second series of tests. A comparison of A with B and C with D reveals that no change of slope occurs between the lines of the two test series; however, a slight displacement is observed.

Had Equations (1), (1a), (2), (2a), (3), and (3a) been made for an exposure greater than 24 hours, approximately the same results would have been obtained. Evaluation at a shorter exposure period is undesirable because of the initial rapid rate of color change.

Although trends are clearly evident, point scatter is pronounced. This is possibly influenced somewhat by irregularities of storage conditions caused by defrosting of the cooler coil and the inability of exact humidity control. As defrosting, when required, was of short duration and average humidity values were obtained from dry and wet bulb recorder charts deviating no more than 3%, storage irregularities are believed secondary to the variant behavior of apparently similar meat samples. This observation is apparently not surprising to the meat chemist.

To alleviate the divergent reaction of apparently similar meat samples, a second series of tests were conducted using 5 samples simultaneously with the objective of obtaining more reliable data from the average of 5 values. All tests were concluded after 24 hours of operation and results were analyzed for this time only. Temperature and air speed corrections were made in accordance

with Equations (1), (1a), (2), and (2a) and the results plotted in Figure 5. It is pertinent to emphasize that the second series

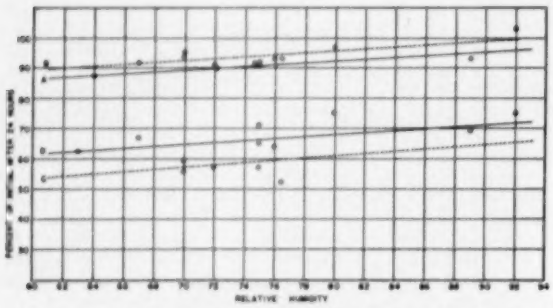

Figure 5. Influence of relative humidity on the degree of desiccation and discoloration of beef samples after a 24-hour exposure.

Line A—Weight For Second Series.
Line B—Weight For First Series.
Line C—Color For Second Series
Line D—Color For First Series.

of tests were conducted with choice grade beef subjected to a special tenderizing process contrasted to the first series in which utility grade samples were employed. Unfortunately the average obtained from 5 samples failed to depress point scatter as had been anticipated. Samples from different carcasses were necessarily employed from one test to another, possibly being an important contributor to the scattered results, however, significant differences were observed among the five samples of a particular test all cut from the same carcass and obviously subjected to identical storage conditions.

In obtaining the reflectivity of a sample in the photronic intensity meter, exposure to the light beam was for a duration of a few seconds only and was not considered a disturbing factor. A special observation revealed that an exposure of ½ hour was required before surface darkening was accelerated.

CONCLUSIONS

Either an increase in dry bulb temperature or air speed accelerates the dehydration and discoloration of beef samples. However, within the usual range of storage conditions the increase is not appreciable. The rate of dehydration and discoloration is reduced as the relative humidity increases.

During the first few hours after the meat sample is exposed, surface discoloration proceeds more rapidly than dehydration; however, after a few hours the rates are almost parallel. Accordingly, for usual storage periods, an environment conducive to low dehydration tends to preserve the surface color.

Further investigations in this field should be conducted with the aid of meat chemists to achieve a workable standardization of meat samples.

Acknowledgments

The research committee of the American Society of Refrigerating Engineers suggested that a study be made of the effects of temperature, relative humidity, and air speed on the blackening of meat while kept in storage. This research was financially supported by grants from the American Society of Refrigeration Engineers, the University of Kentucky Engineering Experiment Station, and the University Research Fund. Dean D. V. Terrell of the College of Engineering provided laboratory space for the research. The authors greatly appreciate the assistance of the foregoing sponsors in making the research possible.

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Improving the Keeping Quality of Eggs During Marketing by Hot Oil Treatment[a]

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It is shown that the keeping quality of soiled eggs washed in cold water is greatly improved by agitating them soon after washing in a hot water bath at 144° F. or in a hot oil bath at 152° F. for two minutes. The 2-minute hot oil treatment seals as well as sanitizes the shell and has other advantages such as saving labor. It is also less detrimental to the functional properties of the egg than the longer (10-15 minutes) treatment.

Practically all eggs are of high quality at the time they are laid. Deterioration starts at once, proceeds rapidly the first few days, and then slows down. Recent surveys *(17, 19, 28)* have shown that more than 30% of the eggs have dropped below Grade A by the time they leave the farms. Another 30% drop in quality in passing through the buying stations, assembly plants, terminal markets and into the retail stores *(15, 28)*. Similar drops in quality have been reported for car lot shipments of eggs *(13)*.

Oil treatment of eggs, to preserve quality while held in cold storage, has been widely used *(9)*. It has generally been applied at the assembly station or terminal market, seevral days after the eggs have been laid and after the quality has started to decline *(2, 5, 10, 24, 25, 30)*. More recently, a hot oil treatment lasting about 15 minutes has been advocated *(2, 7, 8, 9, 11, 12, 14)*. This longer treatment not only reduces moisture loss, absorption of odors, escape of carbon dioxide, and a high alkalinity (as in the cold oil treatment) but also stabilizes the white, kills the germ of fertile eggs, and greatly reduces spoilage.

Most of the studies reported on the hot oil treatment (thermostabilization) of eggs have been made on eggs held in cold storage *(7, 9, 11, 12, 22)*. Strictly fresh eggs were seldom used, nor was the decline in quality observed in the normal marketing channels, where it is much more rapid than in cold storage *(21, 31)*. In some instances the data on quality are insufficient or inconclusive. A shorter treating period, if effective, would save time and equipment for the industry.

The main objective of the study reported here was to determine the influence of the temperature of oil during a two-minute treatment on the keeping and functional properties of eggs held under conditions simulating those frequently encountered in marketing channels.

PROCEDURES

Soiled washed eggs and high temperature holding conditions were used to test the treatments under the most adverse conditions likely to be encountered.

Eggs were obtained from the University poultry farm. Only eggs with sound shells and of AA or A interior quality were selected. Naturally soiled eggs (more than 20% of the shell surfaced soiled) and artificially soiled eggs, not over 24 hours old, were employed in the different trials. Artificial soiling was accomplished by holding each egg, by the ends, between the thumb and index finger; dipping it in water (100° F.-110° F. or 38° C.-43° C.), and then pressing it into a semisolid paste of dirt (chicken manure, floor litter, yard soil and nest dust) until about one half of the surface from end to end was soiled. The eggs were then placed, soiled surfaces up, on egg case flats and dried overnight at room temperature. The eggs were divided randomly into lots for treatments and controls.

Washing of soiled eggs at room temperature 65° F. to 70° F. (18° C. to 21° C.) was done with a cloth in a bucket of cold tap water at 55° F. to 60° F. (13° C. to 16° C.). The eggs were not rinsed. They were dried in front of a fan, treated and/or stored within 24 hours.

Heat treatment was applied by 2 different methods. The eggs were agitated automatically when held in water or oil for several minutes. This was accomplished by fastening the basket of eggs on the paddle shaft of a washing machine (Figure 1) and reducing the gears so that the paddle moved back and forth 10 times per minute. The washing machine was filled with water and with egg treating oil to a height which covered the eggs. Heat was applied by an electric heating element. The temperature was adjusted by means of a rheostat.

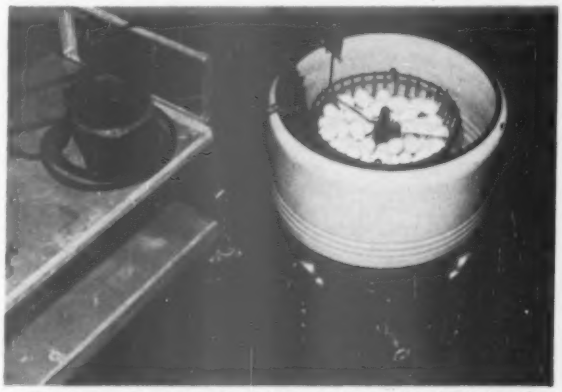

Figure 1. A converted washing machine for heat treating shell eggs in oil.

The eggs were agitated by hand in a thermostatically controlled egg washer (Figure 2) in the later trials and the time was reduced to 2 minutes. The basket was turned back and forth one quarter turn, 10 times per minute in the water and in the egg treating oil. The temperature variations in the oil and water treated baths fluctuated about 2° F.

The oil used was a light paraffin base mineral oil recommended for treating eggs. It had a viscosity of 50 to 55 (Saybolt seconds), pour point at 35° F. (2° C.), and specific gravity of 0.825 to 0.833.

After treatment the basket was removed and the eggs allowed to drain, dry, and cool for an hour in front of a fan. Eggs were candled after treatment (just before holding) and again at the end of the storage period. Eggs of AA quality were assigned a value of 4, A a value of 3, B a value of 2, C a value of 1, and inedibles 0. The percentage decline in candling grade was calcu-

[a] This study was supported in part by U. S. D. A., PMA and ARA, BAI funds allocated to the Ohio Agricultural Experiment Station and was part of North Central Regional Project NCM-7 entitled "Minimizing quality losses in Shell Eggs and Dressed Poultry in Market Channels."

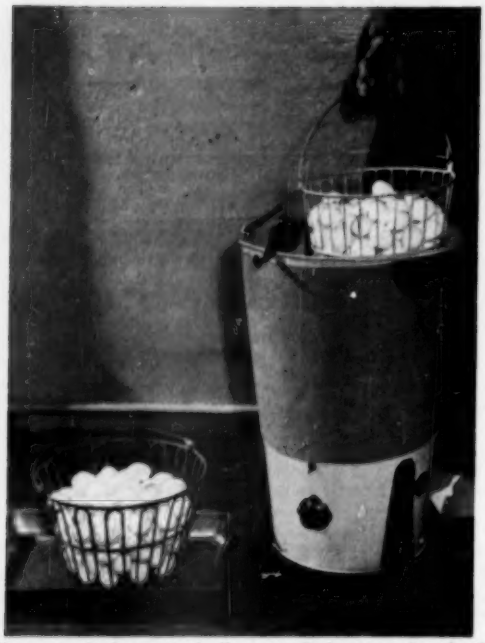

Figure 2. A thermostatically controlled egg washer for heat treating shell eggs in oil.

lated from the difference in candling grade at the beginning and the end of the test.

Holding conditions for the eggs were for 3 weeks in an incubator at 80° F. (27° C.) and 70° F. (21° C.) wet bulb reading. These conditions simulated extreme holding conditions—summer temperatures without refrigeration, and a long period in the marketing channels, respectively.

Broken out examination followed the final candling at the end of the holding period. The eggs were examined for abnormal odors, presence of yolk (stuck yolk) adherence to the inner shell membrane, and fluorescence as determined by passing before a fluorescent candling light.[b] The albumin score *(29)* and percentage of thin white *(1, 11)* that passed through an 8-mesh screen in 2 minutes were also determined.

Functional properties of the white were determined by beating meringue and angel cake volume and score tests *(4, 16, 24, 26)*. Whites from one dozen eggs, receiving each treatment, were separated and blended in a Waring blender to give a uniform mixture of thick and thin white. They were blended at reduced speed for 30 seconds by placing a variable volt transformer[c] in the circuit to the blender and setting the dial at 50. This procedure produced a good blend without the incorporation of much air.

A modification of the Slosberg *(26)* method was used for the meringue and angel food cake tests. It consisted of egg white 122 g., cream of tartar 1.8 g., salt 0.6 g., sugar 125 g., and flour 45 g. The meringue consisted of the white, the salt, cream of tartar and 94 g. of sugar, the latter added in 4 equal amounts, between 3-second beating periods, and the final mixture was beaten to a finish. After recording the beating time and determining the specific gravity of the meringue, the remainder of the ingredients were incorporated and 90 g. of the batter used for baking the cake. Two cakes were baked from each mix, one for determining cake volume and the other for use in scoring. Ten replications were made. The cakes were scored by 4 home economists on the basis of moisture, texture, lightness, and tenderness.

RESULTS

Small numbers of eggs, usually one to four dozen per treatment, were used in each trial. The trials were repeated several times, at different seasons of the year, and with eggs varying in age and shell surface soilage. Wide variations in the results of the different trials were obtained with washed, unheated eggs. This was probably due to different bacterial flora encountered in different trials. Similar wide variations have been reported in egg cleaning and sanitizing trials *(18, 31)*. The data have been summarized in Tables 1 and 2.

Washing soiled eggs in cold tap water increased spoilage from 6.1 to 14.9% (Figure 3) when they were held at 80° F. (27° C.) for 3 weeks. Washing increased the percentage of stuck yolks but had no influence on the grade decline, beating time, or percentage of thin white.

The higher the temperature used in water treatment of the washed eggs, the lower the percentage of spoilage (Figure 3). The high temperature water treatment did

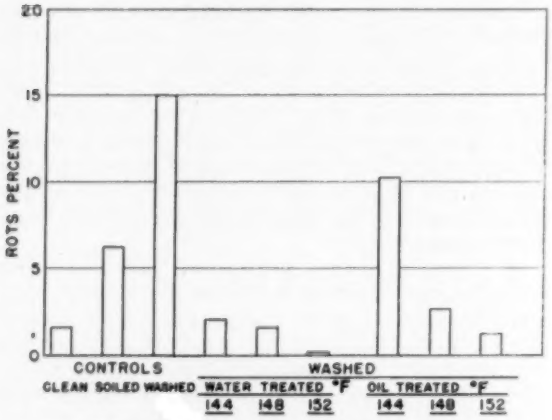

FIG. 3 INFLUENCE OF HEAT TREATMENT ON SPOILAGE OF WASHED EGGS

Figure 3. Influence of heat treatment on spoilage of washed eggs held at 80° F. for three weeks.

not result in an increase in the percentage of stuck yolks. Funk *(9)* reported a higher percentage of stuck yolks when eggs were treated in water at 145° F. (63° C.) for 3 minutes than at 130° F. (54° C.) for 15 minutes. However, he reported a low incidence of stuck yolks when recently laid eggs were used and cooled immediately after heat treatment. In a few of our trials, the washed eggs were dipped 2 to 5 seconds in boiling water. The sudden change in temperature resulted in a few cracked eggs. This treatment did not result in good keeping quality of eggs. This agrees with the work reported by Funk *(9)* and not that by Romanoff *(20)*. The longer time of exposure also resulted in some coagulation of white. Other workers *(6)* have reported that dipping eggs as above for 2 to 3 seconds will destroy most *Pseudomonas* bacteria.

Water treatment during agitation at 144° F. (62° C.) for 2 minutes did not harm the functional properties of either AA or low A quality shell eggs. However, eggs of low A quality began to show some coagulation of the white when treated at 148° F. (64° C.) for 2 minutes. When heated at 152° F. (67° C.) for 2 minutes, both good and average quality eggs showed definite signs of white coagulation. This treatment resulted in a definite increase in beating time of the white; decrease in per-

[b] No. -EIL-KC, H4, Keese Engineering Co.
[c] American Instrument Co.

centage of thin white (Table 1); increase in beating time of meringue; and, a decrease in angel food cake volume (Table 2). However, the cake volume and score were still quite satisfactory. It appears that egg white injury (coagulation) will be apparent to the eye (flecks and milky-like) before it becomes unsatisfactory for making angel food cakes.

It required about 8° F. (5° C.) higher heat treatment in oil than in water (Table 1) for prevention of rots; this increase in temperature did not affect the functional properties of the white adversely. This agrees with previous reports *(9, 22)*. Treatment in oil reduced the loss in candling grade when compared with water treatment.

Long time (10 to 15 minutes) treatment of eggs in oil at 130° F. (54° C.) to 140° F. (60° C.) was more detrimental to the functional properties of the white than a shorter treatment (2 minutes) at a higher temperature (156° F. or 69° C.). The results of these studies indicate that shell eggs of good and medium quality may be agitated in oil at 152° F. (67° C.) for 2 minutes without apparent harm to their functional properties. When treated in oil at 156° F. (69° C.) for 2 minutes, however, some of the eggs, especially small ones and those of low A quality, showed signs of coagulation of the white.

SUMMARY

The keeping quality of soiled eggs washed in cold water may be greatly improved by agitating them soon after washing in a hot water bath at 144° F. (62° C.) or in a hot oil bath at 152° F. (67° C.) for 2 minutes. A hot oil treatment is superior to a hot water treatment because it seals as well as sanitizes the shell. Hot oil treatment (152° F. or 67° C. for 2 minutes) will greatly prolong the keeping quality of shell eggs stored without refrigeration. A short time (2 minutes) high temperature (148° F. to 152° F. or 64° C. to 67° C.) oil treatment of shell eggs is more labor saving and less detrimental to the functional properties of the eggs than the longer (10 to 15 minutes) conventional treatment *(9)* at lower temperatures (130° F. to 140° F.) (54° C. to 60° C.).

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TABLE 1

Influence of hot water and hot oil treatment on keeping quality of soiled washed eggs

Treatment	No. of eggs	Temp.	Time	Rots	Stuck yolks	Grade decline	White		
							Beating time	Score	Thin
		° F.	*Min.*	*%*	*%*	*%*	*Sec.*		*%*
Clean	432			1.5	7.2	57	36	4.0	74
Soiled	761			6.1	7.3	44	37	4.0	86
Washed	981			14.9	12.5	47	37		77
Water treated	96	140	2	6.0	4.0	37	29		
Water treated	838	144	2	2.0	5.3	31	36		70
Water treated	287	148	2	1.5	5.6	36	38		68
Water treated	96	152	2	0.0	2.0	46	43		47
Oil treated	144	130	15	8.0	1.0	3			
Oil treated	144	140	10	4.0	0.0	0			
Oil treated	693	144	2	10.2	4.0	21	38		
Oil treated	288	148	2	2.5	1.0	15	36		49
Oil treated	336	152	2	1.1	1.5	12	36		55
Oil treated	286	156	2	1.4	1.4	14	46		49
Oil treated	48	160	2	0.0	0.0	23	46		

TABLE 2

Influence of shell egg heat treatment on the functional properties of the white

Trial	Treatment				Foam		Meringue		Cake	
	Agitated in	Temp.	Time	pH	Beating time	Specific gravity	Beating time	Specific gravity	Volume	Score
		° F.	*Min.*		*Sec.*		*Sec.*		*ml.*	
1 [1]	Unheated (control)			8.7	13	.12	31	.26	444	9
	Oil	144	2	8.3	12	.11	37	.27	445	9
	Oil	140	10	8.3	54	.21	73	.34	409	8
	Oil	130	15	8.3	31	.17	48	.31	395	8
2 [1]	Unheated (control)						25	.18	492	9
	Water	148	2				31	.20	474	7
	Water	152	2				38	.21	458	7
	Water	156	2				43	.22	449	7
	Oil	156	2				32	.20	480	7
	Oil	164	2				41	.21	454	6
	Oil	168	2				52	.22	442	7

[1] Eggs of low A grade quality were used in Trial 1 and AA or high quality in Trial 2.

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Modification of Skin Texture of Canned Italian Prunes

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Calcium was found to be an important factor in determining the skin texture of canned Italian prunes and the presence of calcium in the canning sirup caused an increase in the skin toughness of this product. Sodium hexametaphosphate, when added to the canning sirup, had a tenderizing effect and its use permitted standardization of skin texture. The tenderometer, when suitably adjusted, was found to provide a useful objective index of skin texture.

Canned Italian prunes are an attractive, flavorful product that is packed almost exclusively in the Pacific Northwest. To reduce the possibility of consumer confusion with dried prunes the product is often marketed as purple plums. The annual pack fluctuates between one and three million cases, depending on supply and price of fresh fruit. From 16 to 30% of the total crop is canned *(10)*. A greater proportion of the crop is expected to become available for canning as new plantings come into bearing.

Consumer acceptance of canned Italian prunes has not been as great as might be expected from the quality of the product, and difficulties have been encountered in the past in marketing the larger packs. A serious detractant from the eating quality of this canned fruit is its undesirably tough skin. The problem is complicated by a considerable variation in skin texture, so that the consumer may on one occasion obtain a product with reasonably tender skins and on another, one with very tough skins. Skin texture appears to vary with season, variety, maturity, and with the area in which the fruit is grown. Considerable variation may also occur between different prunes in a single can prepared from an otherwise uniform lot of fruit. To avoid extremely tough skins some canners restrict their purchases of fresh

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prunes to those areas which generally produce fruit having more tender skins.

This report presents results of a study to develop a processing method to tenderize the skins of canned Italian prunes and permit standardization of skin texture in the commercially canned product. It was realized that tenderizing must be accomplished without detracting from the color, flavor, or general appearance of this product.

Unpublished studies in this laboratory on pre-canning treatments to partially digest the prune skins demonstrated such an approach to be impractical, because all of the characteristic color of this fruit is in the skin tissue. Dipping the fresh fruit in boiling solutions of alkali phosphates, sodium hexametaphosphate, or hydrochloric acid of suitable concentration for periods sufficient to accomplishing practical tenderizing was always accompanied by a loss in the attractive, deep, red-purple color of the sirup and the skins were faded to an undesirable brown color. Preliminary experiments on the effect of adding sodium hexametaphosphate to the canning sirup indicated that this compound might prove useful in solving the problem. Data presented in this report were obtained in the course of a study to confirm these preliminary observations and determine the practical value of the treatment.

The effect of calcium in firming the texture of tomato tissues has been reported *(4)* and this effect has been identified as due to the reaction of calcium with pectic substances in the tissues *(5)*. Similar results have been reported for apples *(9)*. The use of sodium hexametaphosphate in the blanching water has been found to tenderize the skins of frozen peas, lima beans, and green beans *(8)*. The action of this compound is presumably due to its ability to form a soluble complex in which the calcium is not ionized and thus is removed from actual participation in texture forming tissues. This property of sodium hexametaphosphate has also been reported to increase the viscosity of tomato sauces *(1)*, to increase the yield and viscosity of tomato juice *(7)*, and to aid in the extraction of pectin from fruit pomaces *(2)*.

EXPERIMENTAL PROCEDURES

Sample preparation. Medium-sized Italian prunes, free from external blemishes, were washed and carefully composited into uniform lots. Each lot was then filled into enameled No. *2* cans to 12 ± ⅛ oz., with the same number of prunes in each can. Accurate fill was essential in this study because actual treatment depended on the fruit-sirup ratio in each can. The cans were filled with sirups at 180° to 200° F. (82° to 93° C.), exhausted in steam 5 minutes, sealed, cooked *20* minutes in boiling water, and cooled in water. A 30% sucrose sirup, prepared from distilled water, was used for all lots in which sirup additions were studied. Different amounts of sodium hexametaphosphate, trisodium ethylenediamienetetraacetate (a chelating agent), calcium chloride, or magnesium chloride, were added to the sirup used for each lot. The amount of these materials used is reported on the basis of percentage, or parts per million, by weight, in the sirup. The amount present in the canned product would be about 8/20 or 40% of that present in the sirup for the No. *2* can. This ratio would vary somewhat, depending on the size can used. It would amount to about 44% for the No. 303 can and about 37% for the No. 2½ can. Four lots were also canned with sirup prepared from water of known hardness and calcium and magnesium content. One lot of fruit was peeled before canning by dipping in a boiling 1% solution of hydrochloric acid followed by thorough water rinses. More than the usual number of fruits were filled into the cans to make up the weight loss in peeling.

Analytical methods. A glass electrode was used to determine the pH of the canned prunes and total titratable acidity was determined on 10 ml. aliquots of sirup diluted to 100 ml. and titrated to a pH of 8.1 with 0.1 N sodium hydroxide using a glass electrode. Color of prune sirup was determined by measuring transmittancy at 515 mμ with a photoelectric colorimeter. The sirup was first diluted 1 to 5 with distilled water and filtered through glass wool. Adsorption was compared against a distilled water blank. Spectrophotometric examination of sirup from canned prunes in the visible spectrum showed a maximum absorption at about 525 mμ for both distilled water-sucrose sirup and similar sirup to which 1% sodium hexametaphosphate had been added. Total hardness and calcium and magnesium content of the water samples were determined by the versenate titration method using an oxalate separation of calcium *(3)*.

Skin texture evaluation. The tenderometer developed for grading green peas *(6)* was used to measure skin texture of the canned prunes. It was assumed that values obtained with this instrument would represent that portion of the sample offering greatest resistance to shear, which in canned prunes is the skin tissues. To adapt the instrument for prunes the pendulum weight was reduced to balance against an 18 lb. 12 oz. weight on the test bar. The drained and pitted prunes from an entire No. *2* can were placed in the instrument for each determination and the values recorded from the lower, 1 to 50 scale. Six or 10 measurements were made for each treatment.

Organoleptic tests. Scoring tests were made to compare objective tenderometer values with organoleptic evaluation of skin texture. The judges were presented with 4 samples in coded beakers and asked to score them on a 1 to 10 scale on the basis of skin toughness. The most tender sample was to be scored 1, the most tough 10, and the others intermediate according to relative skin toughness. The samples, consisting of 4 quarters from 4 different prunes, were presented in subdued light to prevent differentiation on the basis of appearance.

The triangle difference test was used to determine the effect of sodium hexametaphosphate on the flavor of canned prunes. Sirups drained from the canned fruit were used in these tests to prevent identification by texture. Judges were asked to select the old sample among three 50-ml. portions presented in coded beakers. The sirups were first allowed to come to room temperature, and the position of the odd sample with respect to the pair was randomized.

RESULTS AND DISCUSSION

Effect of additives on skin texture. Results of tenderometer measurements on prunes canned with sirups containing various amounts of sodium hexametaphosphate or calcium are presented in Figure 1. The values shown were obtained after 3 months' storage and

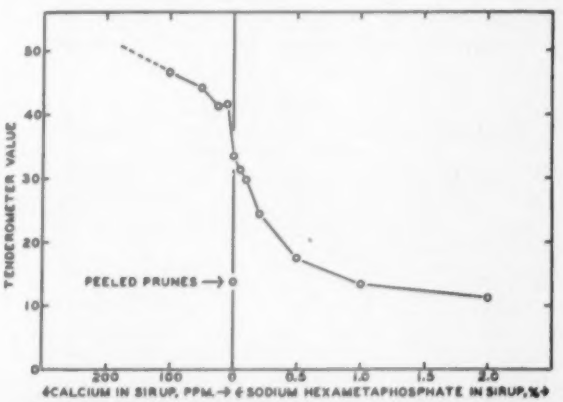

Figure 1. Effect of addition of calcium and sodium hexametaphosphate on texture of canned Italian prunes.

each point represents the average value from 10 measurements. The curve between 100 and 200 p.p.m. calcium has been projected to cross the tenderometer value line of 50 at an intermediate point because all values obtained on prunes canned with 200 p.p.m. calcium exceed 50, the limit of the tenderometer scale. Also shown is the average value obtained from acid-peeled prunes. The standard deviation for the mean tenderometer values for all samples in this study was 2.62. It was, however, less (1.37) in the lower part of the scale.

Data presented in Figure 1 show that the presence of sodium hexametaphosphate in the canning sirup has a profound effect in tenderizing the texture of the canned prunes, as measured by the tenderometer, and that this tenderizing effect is proportional to the amount of this compound present. When 1.0% sodium hexametaphosphate was added in the sirup, the canned prunes had a texture comparable to peeled prunes canned in sirup prepared from distilled water. Tenderizing was accomplished without appreciable change in the shape of the fruit or in the amount of split skins.

That the treatment had a tenderizing effect on the flesh is apparent from the tenderometer value obtained when 2.0% sodium hexametaphosphate was added to the canning sirup. This value was significantly lower ($P<0.01$) than that for peeled prunes. Softening of the flesh appeared to be a secondary effect, however, and was not noticeable organoleptically in prunes canned in sirup containing 0.5% sodium hexametaphosphate and was only slight at 1.0%. In comparing tenderometer values obtained on the flesh of canned peeled prunes with values obtained on prunes canned with peel intact it must be recognized that the presence of skin tissue in the can may result in a softer flesh. The possibility that skin tissue sequesters calcium present in the flesh is suggested by the rapid initial increase in skin toughness during storage demonstrated in the next section.

The data also show that toughness was increased by the presence of calcium in the sirup. This toughening was quite pronounced even at low concentrations of calcium but toughness, as measured by the tenderometer, was slightly erratic. These observations are confirmed by the data obtained on comparable lots of fruit, when several hard waters were used in preparing the canning sirup as shown in Table 1. Total hardness and calcium and magnesium contents of these waters are shown, together with average tenderometer values for prunes canned in sirups prepared from them. Also shown is the tenderometer value obtained on prunes canned in the hardest of these waters after it had been softened by the addition of sodium hexametaphosphate at a rate of 1½ oz. per 100 gallons per grain of hardness.

TABLE 1

Effect of water used in preparing sirup on skin texture of canned Italian prunes

Water	Total hardness, as $CaCO_3$, p.p.m.	Total hardness, as Ca, p.p.m.	Calcium, as Ca, p.p.m.	Magnesium, as Ca, p.p.m.	Tenderometer value of canned prunes (av. of 10 samples)
A	22.0	8.8	0.0	8.8	35.2
B	48.4	19.4	3.8	15.6	41.8
C	136.0	54.5	30.8	23.7	41.6
D	508.0	203.2	137.6	65.6	>50.
D (softened)[1]	.....	.....	.....	.....	30.9
Distilled	.....	.....	.....	.....	33.6

[1] Sodium hexametaphosphate added at rate of 1½ oz. per grain of hardness per 100 gallons.

Included in this study were several additional treatments on equivalent lots of fruit so that tenderometer values would be directly comparable. One treatment involved the addition of 200 p.p.m. of magnesium to the sirup in the form of magnesium chloride. The average tenderometer value for canned prunes receiving this treatment was 33.9 as compared with 33.6 for the untreated control. A similar lack of effect on skin texture was observed when 1.0% of trisodium ethylenediaminetetraacetate was added to the sirup. This is not surprising since the chelating capacity of this compound is quite low at the pH encountered in canned prunes.

Changes in toughness during storage. A study was made to determine the rate of action of sodium hexametaphosphate and the effect of storage on skin texture since this compound is unstable and reverts to the orthophosphate quite rapidly in acid solution, particularly at high temperatures *(11)*. Treatments used in this study included prunes canned in sirup prepared from distilled water, in similar sirup to which 0.5% sodium hexametaphosphate had been added, and in sirup to which 200 p p.m. calcium had been added as calcium chloride. Texture measurements were made by means of the tenderometer on 6 cans of each treatment one day after canning and then at intervals during 8 months' storage.

Results of this study (Table 2) show that the skin texture of prunes treated with sodium hexametaphosphate was tenderized within one day after canning and increased only slightly during 8 months of storage. In contrast, prunes canned in sirup prepared from distilled water were comparatively tender one day after canning but increased markedly in toughness during the first week of storage. The texture then appeared to remain relatively constant during a total of 8 months' storage. There is no apparent explanation for the high values obtained in this treatment after 4 months' storage or the higher values obtained for the sodium hexametaphosphate treatment after 4 weeks, 2 months and 4 months of storage. As discussed in the previous section, the rapid increase in skin toughness may result from a sequestering action by the skin tissue on the calcium in the flesh. The toughening effect of calcuim in the sirup was apparent that day after canning and this fruit also showed a rapid further increase during the first week of storage. Unfortunately, at this level of calcium addition the toughness began to exceed the tenderometer scale after 18 days so that average values were not obtainable.

The rapid tenderizing effect of sodium hexametaphosphate, and the relative stability of the texture of prunes receiving this treatment would provide a convenient method for standardizing the texture of this product. Representative samples of fruit from each lot could be canned in sirup containing several levels of sodium hexametaphosphate and that level giving the desired texture determined on the following day. These

trial packs would permit varying the amount of material added to a commercial pack to compensate for differences in texture encountered from season to season, between different producing areas, and between varieties. Differences in texture between individual prunes in a given lot appeared to be reduced but not entirely eliminated by the treatment.

Organoleptic evaluations. Table 3 presents average tenderometer values and results of taste tests conducted on two series of samples varying in skin texture. In these tests judgments of all tasters in an unselected panel were used. These data show that the tenderometer is an accurate index of skin texture as determined by the eating quality of canned prunes. That the tenderometer would be more sensitive to small differences in skin texture than the taste panel was expected because of the differences in texture between prunes of the same treatment. Where the judge had an opportunity to evaluate parts from only 4 prunes the tenderometer values represent 120 prunes. The fact that the taste panel fruit was cut into quarters also probably reduced the ability of judges to discriminate between degrees of toughness.

No significant differences ($P>0.05$) were obtained in 4 taste panel comparisons of the flavor of sirups from prunes canned in distilled water sirup with prunes canned in sirups containing sodium hexametaphosphate in amounts ranging from 0.5% to 2.0%. Only in the test involving the 2.0% sodium hexametaphosphate treatment did judges offer to comment on flavor. In this test four of the correct judges questioned the flavor of the sirup receiving the highest treatment and the flavor was described as flat, slightly off, or soapy.

Chemical analyses. Results of chemical analyses showed that the addition of sodium hexametaphosphate caused a slight but significant ($P<0.01$) increase in titratable acidity and pH. These increases, +0.07% acid and +0.10 in pH for the 1% treatment, were well within the range that may be expected in canned Italian prunes. The increase in both titratable acidity and pH suggest that it would probably be unnecessary to adjust the pH of sodium hexametaphosphate used for this purpose since neutralization, while correcting the increase in acid, would cause a further increase in pH. Only the 0.5% treatment showed significantly more color in the sirup ($P<0.01$) than the untreated. The appearance of the canned prunes suggested, however, that those samples treated with sodium hexametaphosphate had a slightly deeper color in both the sirup and skin. The sirup from prunes canned with 2.0% sodium hexametaphosphate had a slightly bluer color, presumably due to the increased pH.

SUMMARY AND CONCLUSIONS

The effect of sodium hexametaphosphate, trisodium ethylenediaminetetraacetate, calcium chloride, and magnesium chloride, when added to the canning sirup, on the skin texture and general quality of canned Italian prunes was investigated.

Sodium hexametaphosphate caused a tenderizing of prune skins and this effect was proportional to the amount used. The tenderizing effect was apparent shortly after canning and skin texture remained relatively constant during storage. Within the practical range, 0.2 to 1.0% in the sirup, this compound had no adverse effect on general appearance, color, or flavor of the canned fruit.

Calcium caused a toughening of the skin roughly proportional to the amount present. Amounts as low as 4 p.p.m. in the sirup caused noticeable toughening. Adding sodium hexametaphosphate to hard water in an amount equivalent to the hardness eliminated the toughening effect of the hard water. Toughening due to calcium was noticeable shortly after canning. Skin toughness of prunes canned in a sirup prepared from distilled or hard water increased rapidly during the first week of storage.

The skin texture of canned Italian prunes was not affected by the presence of either magnesium chloride or trisodium ethylenediaminetetraacetate in the canning sirup.

The tenderometer provides a useful objective measure of skin texture in canned Italian prunes.

TABLE 2

Effect of storage on skin texture of canned Italian prunes

Treatment	Tenderometer value after storage. (av. of 6 samples)						
	1 day	7 days	18 days	4 weeks	2 mos.	4 mos.	8 mos.
Canned in sirup containing 0.5% $(NaPO_3)_6$	14.0	15.1	15.3	18.8	18.5	18.4	16.3
Untreated sirup	22.8	32.3	32.3	32.3	31.9	39.0	32.5
Canned in sirup containing 200 p.p.m. calcium (added as $CaCl_2$)	34.6	41.1	1>50	2>50	2>50	3>50	1>50

TABLE 3

Comparison of tenderometer value with organoleptic scoring of skin texture (1-10 scale; 1 most tender and 10 most tough)

Test No. 1—19 judges			Test No. 2—23 judges		
Treatment	Tenderometer value, av.	Panel score, av.	Treatment	Tenderometer value, av.	Panel score, av.
0.2% $(NaPO_3)_6$ in sirup	24.4	2.84	1.0% $(NaPO_3)_6$ in sirup	13.5	1.04
0.1% $(NaPO_3)_6$ in sirup	29.9	4.21	0.2% $(NaPO_3)_6$ in sirup	24.4	4.65
Untreated sirup	33.6	7.11	Untreated sirup	33.6	7.00
25 p.p.m. calcium in sirup	41.2	8.05	100 p.p.m. calcium in sirup	45.7	9.65
LSD 0.05	—[1]	2.14		—[1]	0.99
LSD 0.01	—[1]	2.86		—[1]	1.32
Correlation coefficient (r)	.95			.994	

[1] All treatments significantly different ($P<0.01$) as determined by t test.

Addition of sodium hexametaphosphate to the canning sirup is a simple, effective method for tenderizing the skins of canned Italian prunes. The skin texture of the product may be standardized by means of preliminary test packs to determine the amount of sodium hexametaphosphate required for each lot.

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Food Standardization and Technological Progress[a]

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The Federal Food, Drug, and Cosmetic Act, enacted in 1938 *(1)*, is probably the most important law on the books today—not only to you and me, because of our professional interests—but to the entire populace which consumes and uses food, drugs and cosmetics. That a law regulating the manufacture and sale of such basic articles of consumption and use is vital to a complex society such as ours may not be questioned. What may be questioned is the structure, the shape of the law—how effectively it attains the espoused aims with a minimum of sacrifice to private initiative and freedom. Constant re-examination and re-evaluation of all existing laws is part of our democratic process which recognizes that the ideal law has not yet been written but that we shall constantly strive to attain it.

The particular aspect of the Federal Food, Drug, and Cosmetic Act pinpointed for discussion at this time is food standardization and its alleged stifling effect on technological progress and research.

Section 401 of the Act authorizes the Secretary of Health, Education, and Welfare, whenever in his judgment "such action will promote honesty and fair dealing in the interest of consumers" to promulgate regulations fixing reasonable standards of identity, quality, and fill of container for any food except butter and most fresh and dried fruits and vegetables *(2)*. This section also specifies the procedure to be followed for issuing, amending or repealing these regulations *(3)*. Provisions for notice, public hearing, participation by all interested persons, publication of prospective orders and court appeal insure complete public, administrative and judicial consideration of all identity standards. Pursuant to these provisions, identity standards have been promulgated for more than 235 foods *(4)*. It has been estimated that half of all packaged foods sold in retail stores today are covered by such standards *(5)*.

GROWTH OF THE CONCEPT OF FOOD STANDARDIZATION

The Food and Drugs Act of 1906 *(6)* (the predecessor to the 1938 Act) contained no authority for the government to issue legally binding standards of identity. As a result of this alone, enforcement of the adulteration and misbranding provisions of the 1906 Act proved arduous indeed. To prove that a food product was debased, the government was first confronted with the formidable task of showing in court that, based on consumer expectation, the product, as a matter of fact, was adulterated or misbranded. In essence, this required the government to prove in each case what the standard for the food product should be.

These difficulties eased the way for many debased foods to enter the market, causing consumers to get less than they had bargained for in many instances and causing more than one responsible manufacturer to go out of business, unable to compete with products bearing the same name as his own but economically adulterated. Economic adulteration, as you know, is the replacement, many times unnoticed by the consumer, of more expensive and desirable ingredients by inferior or less expensive ingredients.

This situation, existent for many years, caused the Chief of the Food and Drug Administration, in 1933, to testify before a Senate Committee considering a new food and drugs law that provision for legal standards of identity which would "reflect the expectation of the buyer" was "extremely important" *(7)*. The Presidential message in 1935 urging passage of this new law particularly emphasized the necessity for this provision authorizing the promulgation of legally effective standards *(8)*.

The 1938 Act empowers the Secretary to promulgate reasonable standards of identity, quality and fill of container for foods *(9)*. As a result, once a standard of identity is established for a given food, every product must conform to that standard if it is to be marketed under the name of that food or purports to be, or is represented as, that food. Unless such a product con-

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 29, 1954.

forms strictly to the standard, it is misbranded under Section 403(g) of the Act *(10)*.

The classic Farina Case *(11)* illustrates the far-reaching effect of these food standardization provisions. The government had issued separate standards for farina and enriched farina, following hearings held at a time when the incorporation of vitamins and minerals in foods was becoming popular. In fact, there was then (and probably still is) quite some confusion among consumers as to the efficacy, desirability, and necessity of the various vitamins and minerals and combinations thereof. Accordingly, and based on the record of the hearings, the farina standard that was issued permitted no vitamins or minerals as either mandatory or optional additions. On the other hand, the standard issued for "enriched farina" permitted vitamin D as an optional additive and prescribed the use of certain minimum quantities of vitamin B_1, riboflavin, nicotinic acid and iron.

The Quaker Oats Company had for some 10 years past marketed a farina fortified with vitamin D, but only vitamin D. Its product was labeled "Quaker Farina Wheat Cereal Enriched with Vitamin D" or "Quaker Farina Enriched by the Sunshine Vitamin" thus clearly showing it consisted of farina and vitamin D. There was no question as to the wholesomeness of the product. Nevertheless the government instituted an action against this product contending it violated the Act since it complied with neither the farina nor the enriched farina standards. The United States Supreme Court held in essence that since consumers could think from taste and appearance that the Quaker Oats product was either farina or enriched farina and since the product did not comply with the standard for either food, a misbranding under the Act had occurred. Therefore, this wholesome product was declared illegal and had to be withdrawn from the channels of interstate commerce.

Thus, no matter how beneficial an ingredient may be, or how clearly its presence may be indicated on the label, it may not be used in a food which has been standardized, or which purports to be a food for which an identity standard has been issued, if the standard does not specifically provide for the inclusion of such ingredient. This is what is known as the "exclusive appropriation theory" of an identity standard and, as you realize, its effect is indeed far-reaching. Another example of this exclusive appropriation concept is the Tomato Catsup Case *(12)*. The standard for catsup did not include sodium benzoate as a permitted ingredient. A product was marketed containing sodium benzoate and was labeled "Tomato Catsup with Sodium Benzoate," with all words being given equal prominence. The court ruled that the product violated the law since it purported to be catsup and actually it was not catsup as defined by the standard due to the presence of the benzoate.

A limited avenue of escape from this exclusive appropriation concept was opened by the recent Supreme Court decision in the Imitation Jam Case *(13)*. As a result of that decision, a manufacturer may use in a food which purports to be or is represented as a food for which there is a standard, an ingredient not included in such standard if the food is labeled with the word "imitation" *(14)*. In other words, if a product is labeled "imitation catsup" an ingredient such as sodium benzoate, not provided for in the standard, may be used. However, even this procedure may not be available indefinitely. The Food and Drug Administration and others would like to see the Act amended so as to close this loophole *(15)*.

The concept and effect of food standardization have been criticized with increasing frequency over the past years. One important criticism, which has been voiced by many members of your own organization, is that food standards discourage and even stifle research designed to improve standardized foods. It is urged that research might produce ingredients for standardized foods which would improve such foods, but since these ingredients are not included in the applicable standard, they could not be used without first having the standard amended. To amend a standard might well be a long, tedious and expensive process. In the meantime, the new ingredient, resulting from the expenditure of considerable time and money, cannot be used. Furthermore, an applicant for a standard change cannot know if the requested amendment will be adopted so that all of the time and money spent in research and hearings may turn out to have been wasted. Even if it is adopted, the considerable delay in time might well deprive one of any competitive advantage. Carried to its logical conclusion, this criticism would mean that food standards should be eliminated.

However, I submit that this is a problem which, like others, has its pros and cons. Many interested people have given this subject, with its various and ramified aspects, considerable study and thought *(16)*. It is my personal belief that a proper weighing of all relevant factors results in a conclusion that the consuming public and the food manufacturers are better off as a result of food standards with their attendant disadvantages.

As already stated, the purpose of a food standard is to promote honesty and fair dealing in the interest of consumers. In purchasing a product for which a standard has been issued, or which purports to be a standardized product, the consumer does and can rely upon the name of the food on the label and she knows that the product contains nothing deleterious or harmful in any way. Certainly, this is a worthy objective. Furthermore, food standards are also beneficial to food manufacturers. They protect the manufacturer of a legitimate product against the fraud or cheat. The present Act and its identity standards would have saved many manufacturers who, prior to 1938, were forced out of business by the competition from debased products.

I appreciate that amending a standard may involve undesirable delays and considerable cost. I am cognizant of the extreme situations of the hearing for the bread standards spanning some ten years and involving a record of about 17,000 pages of testimony *(17)*. However, very important factors and considerations are frequently involved in connection with any proposed change in a standard. Is the proposed new ingredient absolutely safe and harmless? Would it actually result in an improvement to the food? Would its use cause such a change that the food no longer would comply with the consumer's concept of such food? Would it promote honesty and fair dealing in the interests of consumers? These and other questions cannot be resolved solely by the opinion of a proponent of a new ingredient. An orderly procedure must be followed and competent conclusions reached by an unbiased agency.

IMPROVEMENTS AND POSSIBILITIES FOR FURTHER IMPROVEMENT

I do not mean to imply that improvements in this picture have not been made or that there is still no room for further improvements. An important improvement, worked out through regulations of the Secretary, authorizes the issuance of temporary permits to deviate from the provisions of identity standards *(18)*. A company which, through advances in food technology, has developed any product variation may be able to obtain from the Secretary a temporary permit to market the standardized product with such variation. These permits were heretofore issued only for new ingredients. A very recent amendment provides also for temporary permits to market a product omitting an ingredient required by the applicable standard *(19)*. Upon a showing that the new ingredient is not poisonous or deleterious and that its addition will have a beneficial result, the Secretary may issue and in the past has issued temporary permits to deviate from the standard for a limited period of time—usually a year. Such permits can also be, and have been, extended. By use of such temporary permits, manufacturers have been able to use new ingredients prior to a standard change and acquire sufficient knowledge and experience for use at the hearing for a standard change.

It is true that, inevitably, standard amending proceedings must be faced which may be lengthy and costly.

Looking ahead, there should be some improvements in this picture of long, time- and money-consuming standard hearings. First, Congress recently passed amendments to the Act popularly referred to as the Hale Bill *(20)*. In the past, a full and complete record had to be compiled with regard to each and every provision of a proposed standard or standard amendment. Experience has shown that with regard to many provisions, there was no objection by anyone. Yet, as a result of the requirements of the Act, complete testimony had to be adduced even for non-controversial matters. The new law eliminates hearings on proposals to the extent they are not controversial. Any proposal to which there is no objection would become effective almost immediately.

In fact, shortly after the new law was passed, the National Canners Association petitioned the Secretary for an amendment to the standard for catsup *(21)* and at present it appears that this amendment will soon be in effect. Under the old law, this could have taken many months and considerable expense.

CHEMICALS IN FOODS

However, let us remember that in the prolonged standard hearings most of the time has been consumed with testimony dealing with the safety of a particular chemical or substance. As food technologists, you certainly appreciate the difficulty that may be involved in reaching a decision as to the safety or harmlessness of a proposed substance, especially when it is a new chemical. In the interests of public health as well as the best interests of food manufacturers, all of us should be anxious to have as complete a record as possible on such a subject, so that the conclusions reached may be sound and correct ones.

Accordingly, I do not believe we will receive much benefit from the new law in the areas where most time has been consumed at hearings. Proposals dealing with new chemicals will probably be objected to by one or more in interest and thus, such proposals will be the subject of hearings to the extent that they have been in the past.

The Hale Bill amends the Act in another significant respect. Previously an application to amend a food standard could be filed only by the industry making such food, or a substantial portion of such industry. This caused certain hardships. A chemical manufacturer, for example, who had developed a new ingredient for, let us say, cheese, could not apply for an amendment to include his new ingredient. Such manufacturer would have had to interest the entire cheese industry or a substantial portion thereof, in his ingredient so that it would file an application for a standard amendment. Under the new amendment, "any interested person, showing reasonable grounds therefor" may file a petition for the issuance or the amendment of a standard. This should have the beneficial result of removing one deterrent to research in certain instances.

A second front of improvement, still only in embryo, is the matter of legislation dealing with new chemicals in foods. We have noted that the most time-consuming phase of standard hearings is that devoted to new chemicals and their safety or harmlessness. Although time and attention is properly required to determine the question of safety of a chemical, it has been often stated that a standard hearing is not the best forum for the determination of safety of new chemicals. Standard hearings are and must be conducted pursuant to certain legal requirements and rules of evidence which allow all interested parties full freedom to examine and cross-examine witnesses *(22)*. A record must be amassed which can provide the basis of appeal to the appellate court. To better obtain a sound and valid scientific conclusion as to the safety of a new chemical, it might be more advisable to submit the matter to the Food and Drug Administration and subsequently hold one or more informal meetings with the government scientists. My experience in the past with a procedure such as this has shown that it fosters scientific discussion and analysis and achieves both valid and prompt results.

Considerable interest has been manifested throughout the country with regard to what has been popularly known as "new chemicals in foods." Under the Act, a manufacturer does not need government permission to use any ingredient he desires in an unstandardized food. Of course, he must declare on the label the presence of all ingredients, and the food must be wholesome and contain no poisonous or deleterious substance. The Food and Drug Administration became concerned with the fact that new chemicals were being used in unstandardized foods and, in at least some cases, the necessary research had not been conducted to be sure that these substances were absolutely safe. Many years might elapse after a particular chemical was first used in a food before the government would even know that it was being used. Thereafter, even assuming the government had sufficient funds, it would be incumbent upon the government to subject the new chemical to the necessary research. In any case where the government eventually found that a chemical was unsafe, it would then have to institute legal proceedings and bear the burden of proving that the food product involved was in violation of the Act. Accordingly, it might well be that unsafe substances could be consumed in large quantities for many years before the government would even be in a position to institute the type of legal proceedings required by the Act *(23)*.

It has been proposed by many that the Act should be amended so as to require precertification of new chemicals. In other words, and similar to the statutory requirements for new drugs *(24)*, before a new chemical could be used in any food, it must be submitted to the Food and Drug Administration, together with the results of the research conducted with regard to its safety. The chemical could not be used unless the government, on the basis of the material submitted to it, certified it as being safe for use. The so-called Delaney Committee, a select committee of the House of Representatives, recommended after extensive hearings:

> "The increasing use of chemical additives in the production, processing, preservation, and packaging of food has created a serious public health problem. The evidence presented reveals that existing Federal laws do not provide complete protection to the public against the addition of chemicals which may be unsafe.
>
> "The strong recommendation of most of the witnesses before the Committe was that no chemical should be permitted entry into the Nation's food supply until its safety for use has been demonstrated beyond a reasonable doubt. A provision in the law to that effect would benefit the food and chemical industries as well as the consuming public. . . .
>
> "In the committee's view, it is important that unnecessary obstacles to technological improvements in food product and processing not be created. . . ." *(25)*.

Following this, bills have been introduced in the present Congress to amend the Act so as to require precertification by the Secretary of all new chemicals prior to their use in food *(26)*. Both prior to and following the introduction of such proposed legislation, many manufacturers of foods and chemicals, representatives of interested government agencies, food technologists and lawyers publicly and privately discussed this very important subject. Numerous papers have been written and published on the subject *(27)*.

Although there is agreement by all interested parties on the basic principle that chemicals should not be used in foods unless they are safe, the suggested paths to attain that objective diverge.

There are those who insist that no additional legislation is required since present laws adequately protect the consumer and point for support to the wonderful record to date of the food industry. The opposite viewpoint, concerned with fringe operators, the small minority it is true, advocate that the Act should be amended so as to require precertification of a new chemical by the Secretary before the new chemical may be used and would have the Food and Drug Administration determine on the basis of information submitted whether any proposed chemical is safe and may be certified. The action of the government would be subject to court appeal. This would follow the new drug provisions of the Act.

Then there are the middle-of-the-roaders who favor an amendment to the Act but are fearful that the government officials who would pass upon the safety of any proposed new chemical from time to time in the future might refuse certification as a result of arbitrariness or super caution. These people, pointing out that there is no objective measuring-stick that can be applied to determine with absolute certainty whether a substance is safe, since in the final analysis the use of trained and scientific judgment is required, would prefer that the decision as to safety be made by a court and jury or by a distinterested group of non-governmental scientists. There is increasing approval of the pattern contained in the Miller Bill *(28)*, dealing with pesticide residues in foods, which authorizes the Secretary to decide whether a new chemical should be certified, but prior to making such decision, the matter and the research data may be referred to an ad hoc advisory committee of scientific experts selected by the National Academy of Sciences for a report and recommendation which must be considered by the Secretary and becomes part of the record to be considered by th appellate court if the Secretary's determination is appealed. It is apparent that proponents of this concept feel that the report of such an advisory committee would act as a deterrent to any arbitrary decision of the Secretary since it would be given considerable weight by an appellate court.

The entire subject of new chemicals in food is probably the most important one today in the field of food and drug legislation, well deserving of the earnest consideration of all interested persons. Appropriate legislation should be enacted to protect the public and serve the best interests of manufacturers as well as to reduce or eliminate the too numerous articles and speeches of uninformed persons and crackpots which have created alarm as to the safety of the food supply of this country.

However, returning to the subject of food standardization, I should point out that should new chemicals legislation be enacted, we shall probably see eliminated that phase of standard hearings which has been criticized as being the most time-consuming and inadequate. In such event, the matter of safety of new chemicals will not be considered at food standard hearings; only efficacy and advisability of a new chemical would be considered. Under such legislation, the chemical would be submitted to the Food and Drug Administration and there would then be one or more informal meetings with the government scientists. I may add that, even in the absence of any such legislation, I have experienced such a procedure more than once and have found that it lends itself to just the type of discussion and analysis scientific people like yourselves desire, and conclusions are reached in a minimum of time.

Let me not appear to be too optimistic. There is not as yet unanimity among all interested persons as to exactly what sort of new chemical legislation should be enacted. Furthermore, present indications are to the effect that no legislation on this subject will be passed this year, so that it may be at least one or two years before we have a new law on this subject. However, I think it is safe to say that eventually we will have legislation on this important subject and that this will occur in the not-too-distant future.

Accordingly, we have already seen some important improvement in standard-making and standard-amending procedures. Further improvements are on the horizon. Can we really say, bearing in mind the public health and the best interests of reputable manufacturers, that food standards deter and discourage research and technological improvements? Without my being in a position to know of all developments and possible developments in the food field since 1938, my limited personal observation has been that food standardization never has prevented scientific investigation with regard to something of real and substantial importance.

However, I do submit and urge that the government adopt a modified attitude towards the manner in which standards are written. Criticism often has been levelled at FDA because in fixing standards it has been "recipe-writing." In addition to setting forth the mandatory ingredients, standards specifically list the optional ingredients, including those that are used solely for flavoring and seasoning purposes. Thus, if a standard permits the use of salt (sodium chloride), a manufacturer could not use potassium chloride in lieu of sodium chloride without first going through everything that is required in order to have the standard amended. Yet, the food basically may be the same food whether it contains sodium chloride or potassium chloride.

To me, the mandatory ingredients are those which give the food its basic character or nature. In the case of mayonnaise, for instance, these are vegetable oil, vinegar and egg. Without these, you simply could not have mayonnaise. When a consumer buys a product labeled mayonnaise, she has a certain expectation which cannot be realized unless vegetable oil, vinegar and egg

are used. Therefore, in the case of mayonnaise, the freezing effect of the standard should be limited solely to those basic or mandatory ingredients.

When it comes to optional ingredients, no real benefit results by freezing them to specifically named substances. Fundamentally, the manufacturer should have the right to do his own recipe-writing.

Some years ago, Mr. Charles W. Crawford, then Associate Commissioner and later Commissioner of Food and Drugs, stated:

> "There may be validity to the criticism that some of the identity standards have been drawn with such rigidity that inconsequential variations which in no wise impinge upon consumer interest are not permitted. In future work it is our purpose to recommend the greatest latitude within standards that seems possible without undue risk. However, we must move with extreme caution when new and insufficiently tested chemicals may be prematurely used in foods through lax wording of the standards. . . . " *(29)*.

In recent years, it has appeared to me that in some cases there has been a lessening of rigidity in standards. However, many of us feel that there could be a considerable improvement along these lines.

You will note that Mr. Crawford said that when it comes to new and insufficiently tested chemicals, extreme caution must be exercised so that they will not be used prematurely in foods through lax wording of the standards. It is apparent that in view of the government's concern about so-called new chemicals, the Administration does not want to have in standards latitude of a type which would permit insufficiently tested new chemicals to be used in foods. I think we can look forward to improvement of this situation at such time as the Congress enacts new chemicals legislation, as there will then be no need or justification for rigidity in standards in order to furnish protection against new and insufficiently tested chemicals in foods.

In conclusion, I submit that the food standards provisions of the Act do accomplish their desired objective, protection of the consumer and the reputable manufacturer from economic and chemical adulteration. The freezing effect produced thereby has been reduced to some extent by official regulations granting temporary permits and by amendments speeding up standard-making and standard-amending procedure. Further amendment in connection with new chemicals is forthcoming. But, the job will not then be completely done. We shall still be concerned with cutting any unnecessary strangulation of initiative while still retaining the desired protection. Until we have the ideal law, neither you nor I will be satisfied.

REFERENCES

1. 52 Stat. 1040 (1938), 21 U. S. C. Sec. 301 et seq. (1946).
2. 52 Stat. 1046 (1938), 21 U. S. C. Sec. 341 (1946).
3. 52 Stat. 1046 (1938), as amended by Public Law 335, 83d Cong., 2d Sess.; 21 U. S. C. Sec. 341 (1946).
4. Food Drug Cosmetic Law Reports (2d Ed.), p. 2001 et seq. This figure does not include standards of quality or fill of container, nor does it encompass the "U. S. Standards" promulgated under the annual appropriation and marketing acts.
5. Interview with Charles Wesley Dunn, President, Food Law Institute, Cambridge, November 1953, as reported in 67 Harvard Law Review 632, 660 (1954).
6. 34 Stat. 768.
7. Hearing before Sub-Committee of the Senate Committee on Commerce. S. 1944, Dec. 7-8, 1933, pp. 35, 36.
8. "In one field of endeavor there is an obvious means to this end which has been too long neglected: The setting up and careful enforcement of standards of identity and quality for the foods we eat. . . .
   "The various qualities of goods require a kind of discrimination which is not at the command of consumers. They are likely to confuse outward appearances with inward integrity. In such a situation as has grown up through our rising level of living and our multiplication of goods, consumers are prevented from choosing intelligently and producers are handicapped in any attempt to maintain higher standards." Message of the President, H. R. Rep. No. 2755, 74th Cong., 2d Sess., pp. 1-2.
9. Section 401, 52 Stat. 1046 (1938), 21 U. S. C. Sec. 341 (1946).
10. Section 403(g) of the Act reads: "A food shall be deemed to be misbranded—(g) If it purports to be or is represented as a food for which a definition and standard of identity has been prescribed by regulations as provided by section 401, unless (1) it conforms to such definition and standard, and (2) its label bears the name of the food specified in the definition and standard, and, insofar as may be required by such regulations, the common names of optional ingredients (other than spices, flavoring, and coloring) present in such food." 52 Stat. 1047 (1938), 21 U. S. C. Sec. 343(g) (1946). A standardized food may also be adulterated under Section 402(b) (1) (1938), 52 Stat. 1046, 21 U. S. C., Sec. 342(b) (1) (1946), if a "valuable constituent" has been omitted, *United States v. 716 cases of Del Comida Brand Tomatoes*, 179 F. 2d 174 (10th Cir. 1950).
11. *Federal Security Adm'r v. Quaker Oats Co.*, 318 U. S. 218 (1943).
12. *Libby, McNeil & Libby v. United States*, 148 F. 2d 71 (2d Cir. 1945).
13. *62 Cases of Jam v. United States*, 340 U. S. 593 (1950).
14. This decision is based on Section 403(c) of the Act which reads: "A food shall be deemed to be misbranded . . . (c) If it is an imitation of another food, unless its label bears, in type of uniform size and prominence, the word 'imitation' and, immediately thereafter, the name of the food imitated." 52 Stat. 1047 (1938), 21 U. S. C. Sec. 343(c) (1946).
15. Crawford, "Gaps in Consumer Protection Under the Food and Drug Law," 6 Food Drug Cosmetic L. J. 807, 811-813 (1951); Fistere, "The Imitation Jam Case—Some Implications," 7 Food Drug Cosmetic L. J. 165 (1952); Gilbert, "Standardized Foods Need Protection," 7 Food Drug Cosmetic L. J. 172 (1952); Garstang, "The Imitation Jam Decision," 9 Food Drug Cosmetic L. J. 92 (1954); note also in this connection the O'Hara Bill, H. R. 2739, 83d Cong., 1st Sess.
16. Peters, "Are Standards of Identity Assets or Liabilities in the Food Industry?" 1 Food Technology 583 (1947); Austern, "The Formulation of Mandatory Food Standards," 2 Food Drug Cosmetic L. Q. 532 (1947); Callaway, "Current Problems in Formulating Food Standards," 2 Food Drug Cosmetic L. Q. 124 (1947); Stapleton, "The Consuming Public," 7 Food Drug Cosmetic L. J. 793 (1952).
17. See *Atlas Powder Co. v. Ewing*, 201 F. 2d 347 (3d Cir. 1952); cert. denied 345 U. S. 923 (1953).
18. 21 Code Fed. Regs. Sec. 3.12.
19. 19 Fed. Reg. 2469 (Apr. 28, 1954).
20. Public Law 335, 83d Cong., 2d Sess.
21. 19 Fed. Reg. 2704 (May 11, 1954).
22. See Goodrich, "Simplifying the Trial of Scientific Issues in Formal Rule-Making under The Federal Food, Drug, and Cosmetic Act," 8 Food Drug Cosmetic L. J. 578 (1953).
23. Crawford, "The Food and Drug Administration's Viewpoint on Chemicals in Food," 7 Food Drug Cosmetic L. J. 85 (1952).
24. Sec. 505, 52 Stat. 1052 (1938), 21 U. S. C. Sec. 355 (1946).
25. H. R. Rep. No. 2356, 82d Cong., 2d Sess. 1, 25 (1952).
26. H. R. 2245 (Delaney), 83d Cong., 1st Sess. (1953), H. R. 4901 (Miller), 83d Cong., 1st Sess. (1953), and H. R. 9166 (O'Hara), 83d Cong., 2d Sess. (1954), revising H. R. 8418.
27. For example: Ferguson, "Chemical Additives in Foods," 6 Food Drug Cosmetic L. J. 34 (1951); Dunn, "Statement Before The House Select Committee to Investigate the Use of Chemicals in Food Products," 6 Food Drug Cosmetic L. J. 72 (1951); Kleinfeld, "Congress Investigates Chemicals in Foods," 6 Food Drug Cosmetic L. J. 120 (1951); St. John, "Chemical Additives," 6 Food Drug Cosmetic L. J. 269 (1951); Dunbar, "Chemical Additives in Food," 6 Food Drug Cosmetic L. J. 431 (1951); Mulford, "Practicality in Regulation of 'Chemicals in Food' Problem," 6 Food Drug Cosmetic L. J. 850 (1951); Bartenstein, "Chemicals in Foods Legislation," 7 Food Drug Cosmetic L. J. 113 (1952); Newton, "Chemicals in Food," 7 Food Drug Cosmetic L. J. 123 (1952); Oser, "A Discussion of Section 403 (a)," 8 Food Drug Cosmetic L. J. 693 (1953).
28. H. R. 7125, 83d Cong., 2d Sess. (1954).
29. 3 Food Drug Cosmetic L. Q. 243, 248 (1948).

Selection of Members of a Food Tasting Panel: Discernment of Primary Tastes in Water Solution Compared with Judging Ability for Foods[a]

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The possibility that sensitivity to primary taste substances (salt, sugar, tartaric acid, caffeine) in water solutions might be related to the ability to detect different levels of these same substances in food was explored. Twenty-two individuals were tested as to their thresholds for primary taste substances in water solutions and their ability to arrange a series of such solutions in the order of their concentration. They were also tested as to their ability to arrange in order foods (pureed applesauce, pureed pumpkin, and mayonnaise) containing different levels of these same taste constituents. Tasters were able to arrange water solutions and foods in proper order with high accuracy. But ability to arrange water solutions in order of concentration was not highly correlated with ability to arrange in order levels of concentration in food; nor did high sensitivity, as indicated by low threshold values, correlate significantly with ability to arrange in order foods of varying concentration of taste substances.

In the selection of a food-tasting panel the question arises as to whether or not the selection should be on the basis of acuity of perception for primary taste substances in water solution. The selection of a judge on the basis of his ability to detect very small quantities of a substance in water solution, or his ability to distinguish differences in concentration, implies that judging ability for substances in water solution is highly correlated with ability to discern differences in foods. A search of the literature fails to reveal studies in which this relationship has been established.

The statement has been made, "There is no evidence that a direct relationship exists between sensitivity to the taste of chemically pure solutions and ability to detect flavors in food products" *(1)*.

The tasting situation for foods is different from that for water solutions, being complicated by the various taste and odoriferous substances present, and by the texture of the food. As stated by Trout *(7)*, Parker believed that in all the complexity of taste mixtures the elements remain essentially distinct, concluding that competition rather than compensation seems to be the rule; yet Kiesow pointed out that small amounts of salt neutralize a sweet taste, while Titchener believed that both sour and sweet contrast with salt.

Whether it is true that taste mixtures compensate each other, or that one taste may be enhanced at the expense of another, the complexity of the food judging situation makes it probable that the primary tastes will be harder to detect in foods than in water solutions.

Only two investigations have been reported in which studies were made to determine the correlation between sensitivity to the four primary tastes and the ability to detect taste differences in the more complex situation of food judging. King *(5)* tested a group of prospective food judges for sensitivity of taste for chemically pure solutions of sodium-chloride, sucrose, lactic acid and caffeine. Then bread was made using different amounts of these same substances. Judging was carried out with the object of discriminating between different levels of the taste substances in series of bread slices. King concluded, "no correlation was found between the group's consistence in judging solutions and its ability to rate correctly the samples of bread containing the various quantities of sodium-chloride, sucrose, lactic acid and caffeine." Hopkins *(4)*, in an experiment planned to evaluate preference in terms of saltiness of bacon, found a low but significant correlation between judges' ratings and actual salt content of bacon.

A number of studies have been carried out to determine the ability of individuals to detect the tastes of sweet, sour, salt, and bitter substances in dilute water solutions. The minimum level that can be discerned is frequently referred to as threshold value or concentration. From such studies we learn that for most people taste thresholds for water solutions fall within the following range of concentrations of basic taste substances *(6)*:

Taste substance, in moles per liter

Threshold	Sucrose	Tartaric acid	Sodium chloride	Caffeine
Low	.003	.00012	.001	.0002
Med.	.0224	.00045	.0217	.0015
High	.05	.003	.08	.005

The food judge may be concerned not only with minimum detectable levels, but with differences in intensity of taste substances. The ability to arrange water solutions in order of increasing concentration of dissolved substance has been studied. Trout *(7)* dissolved sweet, sour, bitter, and salt substances in water and found that stepwise increases in perception are related to geometric increases in concentration of the taste substance. At low levels, arithmetic intervals were detectable. Trained judges detected smaller increments than untrained. Dove *(2)* in testing his D-unit scale, found that just noticeable differences in sweetness of sucrose solutions were as low as 1.1% in contrast with calculations from published data of 16.3 and 28.6%. These studies demonstrate that individuals differ both in their taste thresh-

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olds and in their ability to distinguish intensities of taste in a series of solutions.

The object of the present study was to obtain evidence as to whether there is a dependable relationship between sensitivity to primary taste substances in water solution, both as judged by thresholds and by ability to arrange series of solutions in order of concentration, and the discernment of these same substances in foods.

PROCEDURE

Twenty-two individuals were tested as to their thresholds for the basic tastes of sweet, sour, bitter, and salt, and their discernment of various intensities of these tastes in series of water solutions and in foods. The taste substances used were sucrose, sodium-chloride, tartaric acid, and caffeine. The concentrations used, Table 1, were adapted from the report on tasting procedures by the Bureau of Human Nutrition and Home Economics *(1)* and Knowles' study on taste thresholds *(6)*. The water solutions and the foods were at room temperature when served. The judges tasted and retasted as necessary until they had reached a decision.

Thresholds. Each judge tasted water solutions of the taste constituents, beginning with distilled water and progressing from most dilute through increasing concentrations until he was able to identify the taste of the substance. When the solutions were presented, the taste in the series was unknown to the judge. The first member of the series in which the judge identified a taste without question was regarded as his threshold for that group of solutions. Each series of tests was repeated 3 times. For each judge the minimum detectable level of taste substance in water solution, i. e. his threshold, was considered to be an average of 3 trials. Thresholds for each judge are reported by the number of the solution, Table 2. The molar concentrations of taste substance corresponding to solutions number 1, 2–15, may be found in Table 1.

Shuffled series of water solutions. The same individuals were then asked to arrange in order of increasing concentration, series of water solutions of the sweet, sour, salt, and bitter substances. Each series contained 9 members, one being distilled water, the others different concentrations of one taste constituent.

Preliminary observations indicated that although some judges could not actually name a taste until a comparatively high concentration was reached, they could often tell that there were different concentrations of this un-named substance even though these were below their thresholds.

Each series of 9 shuffled water solutions was selected to consist of various dilutions of one primary taste substance in which 3 dilutions including distilled water fell below the individual's threshold; and five above. When adjusted in this way the concentration of the 4th member in the series of 9 represented the threshold of that person. The probability of placing the entire group of 9 samples in correct order by random selection would be 1/362,880.

TABLE 2

Thresholds for water solutions

Judge	Number of the solution [1] in the series at which the judge identified the taste; av. of three replications			
	Salt	Sweet	Sour	Bitter
A	7.0	7.0	4.6	3.3
B	3.6	4.0	3.3	3.0
C	3.3	6.3	4.6	2.6
D	6.6	5.6	8.0	4.6
E	9.6	11.0	7.3	5.3
F	3.6	5.6	4.6	2.3
G	7.0	8.6	7.6	7.0
H	6.3	7.0	8.0	2.3
I	14.0	10.3	3.6	6.0
J	6.3	8.0	8.3	5.3
K	6.6	5.6	8.0	5.6
L	3.6	5.6	5.0	3.3
M	11.0	11.3	10.3	7.0
N	6.3	8.3	10.0	5.6
O	10.0	8.0	8.0	4.6
P	6.3	6.0	6.3	3.3
Q	8.3	8.0	6.6	3.3
R	5.6	9.6	10.6	9.6
S	13.0	14.0	10.3	10.6
T	5.6	5.3	6.0	3.3
U	10.6	8.6	8.6	6.3
V	9.3	8.0	8.3	5.0

[1] See Table 1 for molar concentrations.

After the judge had arranged the shuffled solutions to the best of his ability in order of increasing concentration, a record was made of the arrangement. A number which represented the concentration was on the bottom of each cup. After the judge had arranged the series, the person in charge of the testing turned the cups over and recorded the placement. The tests were repeated 3 times and the replications averaged.

The following example may be cited: Judge A, whose threshold for *sweet* was solution No. 7 of the sucrose series, was given a shuffled series of water solutions including distilled water, and solutions No. 5 through 12. Her arrangement for trial 1 was: No. 4 (distilled water) solutions 6, 5, 7, 8, 9, 10, 11, 12.

Shuffled series of foods. Similarly, series of foods were prepared and judged. The foods used were pureed applesauce, pureed pumpkin, and mayonnaise. These foods were chosen because of their homogeneous nature and because it was possible to incorporate the desired taste substances to make a uniform blend.

The number of variations in each food series was 7 including one sample which contained no added taste substance. The probability of correct placement by chance alone was 1/5,040.

Preliminary trials were carried out by 3 judges to establish minimum and maximum levels of sucrose, sodium-chloride, tartaric acid, and caffeine to be added to each food. The lowest and highest levels for additions to foods were from least detectable by these judges to distinctly noticeable concentrations. When decided in this way, the lowest levels of taste substances

TABLE 1

Molar concentrations of substances added to water solutions and foods

Sol. No.	Sodium-Chloride (mol. wt. 58.45)				Sucrose (mol. wt. 342.3)				Tartaric Acid (mol. wt. 453.6)				Caffeine (mol. wt. 194.19)			
	Water	Apple-sauce	Mayon-naise	Pump-kin	Water	Apple-sauce	Mayon-naise	Pump-kin	Water	Apple-sauce	Mayon-naise	Pump-kin	Water	Apple-sauce	Mayon-naise	Pump-kin
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.001	.01	.03	.02	.0005	.005	.02	.04	.000025	.0004	.0016	.0008	.0005	.003	.003	.0055
3	.0025	.02	.04	.03	.001	.01	.0375	.08	.00005	.0008	.004	.0016	.001	.004	.004	.007
4	.005	.03	.05	.04	.005	.02	.05	.10	.000077	.0016	.0064	.0032	.002	.005	.005	.0085
5	.0075	.04	.06	.05	.0075	.03	.075	.12	.0001	.0032	.0096	.0048	.003	.006	.006	.010
6	.01	.05	.07	.06	.01	.05	.100	.14	.000176	.0048	.0128	.0064	.004	.0065	.0065	.0115
7	.015	.06	.08	.07	.015	.075	.125	.16	.00025	.0064	.0192	.0096	.005	.007	.007	.013
8	.02				.02				.0005				.006			
9	.025				.025				.00075				.007			
10	.03				.03				.001				.008			
11	.035				.035				.00125				.009			
12	.04				.04				.0015				.01			
13	.05				.05				.002				.0112			
14	.075				.075				.0025				.0125			
15	.1				.1				.005				.015			

added to the foods were higher than the lowest levels used in water solutions for determining judges' thresholds.

After selection of the extremes, intervals were chosen so that the samples to be tested would fall within the desired boundaries, Table 1. Progressions were chosen more as a matter of convenience than as an attempt to fit a pattern. In all cases, the difference between increments equalled or exceeded the 10% changes in intensity of stimuli said by Trout *(7)* to be readily detectable in sodium chloride, sucrose and lactose, lactic acid, and quinine-sulfate solutions. If water solutions are directly comparable with foods, the judges should have been able to detect a difference.

No adjustments for taste thresholds were made with the food series as had been done for the shuffled series of water solutions. Each of the *22* judges received the same series of concentrations.

If the ability to detect differences in water solutions is to be used as a guide for ability to detect differences in foods, then the judge must be given a real chance to detect the differences in the water solutions. This can be done only by taking his threshold value into consideration. On the other hand, foods to be tasted and compared are not subject to such adjustments to the individual. If important differences exist, then it is necessary for the judge to distinguish those differences whether they be small or large, at high levels or low.

Spearman's rank correlation coefficients (ρ) were calculated *(3)* for each judge, between the correct order of placement by increasing concentration, and the actual order as arranged by the judge. This was done for each series of water solutions and each series of foods.

To obtain a picture of the relationship between judging ability for foods and judging ability for water solutions, correlation coefficients (r) were calculated matching each of the *22* judges' ρ's for water solutions with his values of ρ, for each of the food series. The ρ's were transformed to z values *(3)* before correlation coefficients were calculated.

RESULTS

The measure of each judge's tasting ability for a given substance in water solution or in foods was considered to be the rank correlation coefficient between the correct order of placement of each member of the shuffled series versus the actual placement. By calculating the rank correlation coefficient for each series of food or water solutions of each taste substance, sixteen rank correlation coefficients were found for each judge. These values of ρ are tabulated in Table 3.

Discernment of taste increments in water solutions and in foods. Correlation coefficients of ability to arrange in order of concentration water solutions of sweet, sour, salt, and bitter substances versus ability to arrange shuffled series of foods containing additions of the same substances, calculated from the ρ's of the *22* judges are shown in Table 4. These values should indicate in general whether good judging for taste substances in water solution is an indication of good judging for foods varied as to the same taste.

TABLE 4

Correlation coefficients between values of ρ for arrangement of water solutions and values of ρ for arrangement of foods

Water soln. (x)	r		
	Applesauce (x_1)	Mayonnaise (x_2)	Pumpkin (x_3)
Salt	−0.0603	0.0826	0.2628
Sweet	0.5126[1]	0.3771	0.3507
Sour	0.0581	0.1098	0.0948
Bitter	0.5539[1]	0.5044[1]	0.2829

[1] Significant at 5 percent level.

For most of the foods the correlation coefficients between ρ's for water solutions and ρ's for foods were not significant. It must be concluded, therefore, that a judge who was good for testing water solutions would not necessarily be a good judge for testing foods.

The question may be raised, since the concentrations used in foods were not the same as those used in the shuffled series of water solutions, to what extent is a comparison justified? The lowest levels of the added taste substances in the foods, Table 1, fell within the range of low to high thresholds as reported by Knowles *(6)*. According to Trout *(7)* sapient substances in this range of concentration, with the difference between increments which was provided, should be detectable with ease. He states, "within the limits of concentration which did not cause sensations of pain, the sense of taste could readily detect 10% changes in intensity of stimuli in sodium-chloride, sucrose, and lactose solutions, and with a high correlation in lactic-acid and quinine-sulfate solutions. In weak sodium-chloride solutions a 5% change in intensity of stimuli could be detected readily." Apparently, any part of this range which did not cause sensations of pain could be selected for study and comparisons would be justified.

Most of the judges could distinguish with a fair degree of accuracy gradations of taste in the foods as well as in the water solutions. This was shown by the fact that nearly all ρ values for individual judges were above .80. This demonstrates that the taste variations both for the food and water solutions used were discernible in the majority of cases.

In spite of this, a judge who could readily distinguish a taste in one food was not necessarily able to distinguish the same taste in other foods. Further, his ability to detect one kind of taste,

TABLE 3

Rank correlation coefficients for each judge's actual vs. correct arrangements in order of concentration of basic taste substances. There were nine water solutions and seven foods.

Judge	Sodium-Chloride				Sucrose				Tartaric Acid				Caffeine			
	Water	Apple-sauce	Mayon-naise	Pump-kin	Water	Apple-sauce	Mayon-naise	Pump-kin	Water	Apple-sauce	Mayon-naise	Pump-kin	Water	Apple-sauce	Mayon-naise	Pump-kin
A	.99	.96	.66	.98	.97	.85	.96	.91	.98	.87	.92	.99	.86	.76	.64	.52
B	1.00	.95	.60	1.00	.97	.98	.99	.99	.90	.99	.95	1.00	.97	.82	.86	.89
C	.99	.86	.67	.99	.97	.96	.99	.94	.98	.91	.96	.99	.91	.54	.81	.71
D	.99	.96	.85	.96	.97	.91	.88	.95	.98	.98	.93	.99	.93	.81	.67	.67
E	.99	.98	.81	.98	.96	.91	.99	.95	.92	.99	.98	.99	.97	.91	.93	.79
F	.88	.91	.33	1.00	.82	.93	.82	.99	.84	.69	.55	.99	.97	.89	.82	.89
G	.97	.96	.63	1.00	.99	1.00	.89	1.00	.95	.73	.95	.98	.78	.85	.74	.80
H	.14	.96	.17	.99	.06	.80	.95	.96	.01	.92	.98	.96	.41	.61	.51	.68
I	.75	−.36	.13	.07	.56	−.31	.43	.75	.67	.26	.82	.86	.82	.27	.29	.64
J	.92	.92	.86	.91	.90	.83	.87	.96	.87	1.00	.87	.95	.93	.82	.80	.89
K	.96	.99	.76	.96	.92	.95	.87	.99	.91	.83	.86	.98	.89	.76	.88	.80
L	.87	1.00	.55	1.00	.98	.76	.93	.94	.87	.83	.81	1.00	.93	.60	.58	.76
M	.97	.41	.21	.83	.95	.35	.64	.76	.95	.37	.73	.95	.31	.19	.06	.39
N	.59	.87	.93	.98	.84	.87	.93	.99	.91	.94	.89	.98	.93	.88	.83	.76
O	.99	.98	.75	.95	.90	.66	.99	.98	.68	.86	.95	.99	.90	.71	.86	.79
P	.89	.99	.11	.96	.96	.93	.98	.96	.93	.91	.88	.98	.97	.93	.91	.83
Q	.82	1.00	.95	.96	.89	.87	.69	.94	.95	.96	1.00	1.00	.90	.92	.76	.99
R	.96	.73	.37	.99	.98	.96	.99	1.00	.98	.95	.98	.98	.83	.95	.96	.96
S	.94	.81	−.38	.86	.93	.08	.81	.96	.96	.86	.77	.99	.75	.76	.61	.76
T	.94	.91	.89	.98	.95	.92	.96	1.00	.81	.99	.80	.98	.81	.63	.86	.92
U	.89	.81	.51	.87	.92	.49	.73	.98	.82	.68	.91	.99	.85	.74	.77	.76
V	.98	.12	.52	.94	.97	.94	.98	.98	.96	.93	.92	.98	.85	.85	.95	.89

for example bitter, was not reflected in his ability to detect another kind of taste, for example, sweet.

Relationship between threshold value of each judge and ability to arrange shuffled series in order of concentration. The lowest concentration in the shuffled series of water solutions tasted by each judge depended on his individual threshold. But the individual's threshold was not considered in establishing the minimum levels for the food series he tasted. Rather, these levels were selected on the basis of preliminary tasting by 3 persons and represented the minimum that could be detected in these trials.

The lowest levels of taste substances selected for addition to the foods are compared, in the following tabulation, with low, medium and high thresholds reported by Knowles *(6)*. In most cases the concentration of added substance in the lowest member of the series corresponded with medium threshold values.

Substance	Applesauce	Mayonnaise	Pumpkin
Sodium-chloride			
moles/liter	.01	.03	.02
Threshold level	low-medium	medium	medium
Sucrose			
moles/liter	.005	.02	.04
Threshold level	low	medium	high
Tartaric acid			
moles/liter	.0004	.0016	.0008
Threshold level	medium	medium-high	medium
Caffeine			
moles/liter	.003	.003	.0055
Threshold level	medium	medium	high

Since the thresholds of individuals were not considered in determining the lowest concentration of taste substance to be added to the foods, an advantage may have been given to those judges with extra fine perception. Each judge's threshold was therefore checked against his ρ's for foods as well as water solutions to see whether those judges having lower thresholds were those having higher ability to arrange shuffled series in correct order of concentration.

There appeared to be little relationship between an individual's threshold for a given taste and his placement of foods in order of increasing concentration of the same taste as illustrated in Table 5, in which the judges are listed from lowest to highest threshold values for the sweet taste.

The range of concentrations used in this study was sufficiently great so that some, at least, of the samples might have been outside a judge's tasting range. It is possible that a judge might not be able to taste at the lower levels. In that case, the data would show more wrong choices at the lower levels. A count of misplacements shows that there are just as many wrong choices in the higher concentrations as in the lower.

SUMMARY AND CONCLUSIONS

The object of this study was to obtain evidence as to whether there is a dependable relationship between sensitivity to primary taste substances in water solution as judged by thresholds and ability to arrange series of solutions in order of concentration, and the ability to detect different levels of these same substances in foods.

Twenty-two individuals were tested as to their thresholds for sweet, sour, bitter and salt substances in water solution, and as to their ability to arrange in order of concentration shuffled series of water solutions and of foods containing various proportions of the same taste constituents. Sodium-chloride, sucrose, tartaric acid and caffeine were the taste substances usd. The foods were pureed applesauce, pureed pumpkin, and mayonnaise.

Tasters were able to arrange both the water solutions and the foods according to concentration of the added taste substances with high accuracy. In spite of this the ability to arrange water solutions in order of concentration was highly correlated with ability to arrange foods; nor did high sensitivity, as indicated by low threshold values, correlate significantly with ability to arrange in order foods of varying concentration of taste substances.

TABLE 5

Threshold values for sweet taste in water solutions as related to rank correlation coefficients for arrangement of shuffled series varied as to sweet taste.

Judge	Threshold as indicated by no. of soln. in series of 1-15 (av. of 3 rep.)	ρ			
		Water soln.	Applesauce	Mayonnaise	Pumpkin
B	4.0	.97	.98	.99	.99
T	5.3	.95	.92	.96	1.00
D	5.6	.97	.91	.88	.95
F	5.6	.82	.93	.82	.99
K	5.6	.92	.95	.87	.99
L	5.6	.98	.76	.93	.94
P	6.0	.96	.93	.98	.96
C	6.3	.97	.96	.99	.94
A	7.0	.97	.85	.96	.91
H	7.0	.06	.80	.95	.96
O	8.0	.90	.66	.99	.98
Q	8.0	.89	.87	.69	.94
V	8.0	.97	.94	.98	.98
J	8.0	.90	.83	.87	.96
N	8.3	.84	.87	.93	.99
G	8.6	.99	1.00	.89	1.00
U	8.6	.92	.49	.73	.98
R	9.6	.98	.96	.99	1.00
I	10.3	.56	—.31	.43	.75
E	11.0	.96	.92	.99	.95
M	11.3	.95	.35	.64	.76
S	14.0	.93	.08	.81	.96

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The determination of 0:0-diethyl 0-*p*-nitrophenyl thiophosphate residues in tomatoes.

BUCKLEY, R., AND COLTHURST, J. P. *Analyst, 79,* 285-9 (1954).

Residues on the surface are removed by washing the fruit with alc., plant pigments are oxidized with H_2O_2 and the parathion is hydrolyzed to *p*-nitrophenol, which is detd. colorimetrically. Residues in the whole fruit are detd. by extn. of the macerated tomato with *n*-hexane.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Sugars in Caracas cacao beans.

CERBULIS, J. *Arch. Biochem. Biophys., 49,* 442-50 (1954).

The presence of raffinose, stachyose and their products of hydrolysis (melibiose and manninotriose) has been discovered in Caracas cacao beans. There have also been found 3 unidentified reducing sugars; 2 of these were ketose-contg. sugars.

Studies on the interaction of synthetic detergents with proteins in solution.

PALLANSCH, M. J. *Dissertation Abstr., 14,* 598 (1954).

Studies on the interaction of Na dodecyl SO_4 and decyl benzene sulfonate and bovine serum albumin or ovalbumin showed preliminary reversible binding followed by protein mol. deformation.

Threonine and the odor of protein hydrolyzates.

PHILLIPS, D. M. P. *Nature, 173,* 1092-3 (1954).

A method to detect threonine in protein and peptide hydrolyzates by a "characteristic pleasant curry-like, spicy odor" following hydrolysis in sealed tubes by HCl is described.

Interaction of acids of high molecular weight with albumin.

HAMER, D. *Biochem. J., 56,* 610-13 (1954).

Polyacids interact with albumin in salt-free solns. to prevent coagulation of the protein by heat. Polyphosphates (nucleic acids), polysulphates (heparin and dextran sulphate) and polycarboxylates (alginic acid and bacterial polyglutamic acid) were all effective. Effects on optical rotation of the albumin were also demonstrated.

Ultraviolet irradiation of dilute solutions of ovalbumin.

KAPLAN, J .G., ANDREWS, D. H., AND FRASER, M. J. *J. Colloid Sci., 9,* 203-14 (1954).

The action of u. v. radiation of 0.01% solns. of cryst. ovalbumin consists of *2* separable and fundamentally distinct processes: (1) a modification of the structure of the intact mol. involving neither the rupture of peptide linkages nor diminution of ability to form monomol. films if spread from nonisoelec. solvent. (*2*) An extensive fragmentation of the mol. leading to disappearance of ability to form films, and the appearance of base-binding groups as detd. by formol titrations.

Incorporation of C^{14} into various carbohydrates of tobacco leaves after different periods of photosynthesis in $C^{14}O_2$.

VITTORIO, P. V., KROTKOV,G., AND REED, G. B. *Science, 119,* 906-8 (1954).

Total activities of starch and sugars were detd. after they were isolated from tobacco leaves which were subject to photosynthesis in $C^{14}O_2$. It was found that the C from the CO_2 appeared in the starch fraction before it did in sugars.

MICROBIOLOGY

Gelatin liquefaction test for the screening of compounds used or proposed as inhibitors of bacterial proteolytic deterioration in foods.

MOSSEL, D. A. A., AND DEBRUIN, A. S. *Antonie van Leeuwenhoek J. Microbiol. Serol., 20,* 233-40 (1954). (in English).

Gelatin slants are used as a substratum and a *Pseudomonas* strain is used as an inoculum. The coeffs. of variation of the abs. liquefaction data roughly vary from 1-5. The spread in the relative liquefaction data, obtained for various preservatives, amounts to 10% abs. and is not significantly influenced by the use of different batches of gelatin or by differences in intensity of gelatin liquefaction in the strain.

Studies on the efficiencies of disinfectants for use on inanimate objects. I. Relative activities on a stainless steel surface using a new performance test method.

STEDMAN, R. L., KRAVITZ, E., AND BELL, H. *Appl. Microbiol., 2,* 119-24 (1954).

The technic is fully adaptable for use in testing the effects of a no. of environmental variables. Using this method, the relative efficiencies of several representative types of disinfectants were detd. on stainless steel surfaces. Increases in recommended use concns. are recommended in various degrees for certain of the products. The significance of these findings as well as details of the test procedure are discussed.

NUTRITION

Antibiotics reduce protein requirements of broilers.

WEST, J. W., AND HILL, J. E. *Miss. Farm Research, 17,* 7, June, 1954.

The protein requirement for rapid growth in broilers appeared to be reduced from 20-18% when either terramycin or bacitracin was added at the rate of 10 g./ton. Optimal growth and feed efficiency were obtained with the 18% protein ration supplemented with either terramycin or bacitracin. When no antibiotic was added, a protein level of 20% was required to produce the same. These results are in agreement with those that have been reported previously for aureomycin and procaine penicillin.

Exercise, food intake and body weight in normal rats and genetically obese adult mice.

MAYER, J., MARSHALL, N. B., VITALE, J. J., CHRISTENSEN, J. H., MASHAYEKHI, M. B., AND STARE, F. J. *Am. J. Physiol., 177,* 544-8 (1954).

When non-obese and genetically obese mice all accustomed to a sedentary exercise were exercised on a treadmill for 1 hr. a day, and changes in wt. compared to those of non-obese and obese mice not exercised, it was found that exercise did not affect the wt. of the normal mice but considerably decreased the wt. gain of obese mice even though these obese mice responded to exercise by an increase in food intake.

Some effects of excess molybdenum on the nutrition of the rat.

GRAY, L. F., AND DANIEL, L. J. *J. Nutrition, 53,* 43-51 (1954).

The addn. of methionine to the diet markedly prevented the harmful effects of excess Mo. The relationship between Cu and Mo was again demonstrated, as supplementary Cu prevented approx. ⅓ of the deleterious effect of Mo at the mineral levels used in these studies. Supplementation of the diet with both methionine and Cu was no more efficacious in counteracting the toxicity than the use of methionine only.

Effects of massive doses of P^{32} and Ca^{45} on laying hens.

SHIRELY, R. L., DRIGGERS, J. C., FEASTER, J. P., MCCALL, J. T., AND DAVIS, G. K. *Poultry Sci., 33,* 612-15 (1954).

Laying hens that received P^{32} and Ca^{45} showed that there was no adverse effect with Ca^{45} during a 2 year period following dosage. With the administration of P^{32} in smaller doses, the hens died 11-12 days after dosage.

Low-calorie ingredients. Big booster of dietetic foods.

BECK, K. M. *Food Eng., 26,* 87-8+, June, 1954.

Describes uses of sucaryl products in various food products.

Substitution of α-keto acids for five amino acids essential for growth of the rat.

WOOD, J. L., AND COOLEY, S. L. *Proc. Soc. Exptl. Biol. Med., 85,* 409-11 (1954).

Young rats grew slowly on a diet in which the N was furnished exclusively by the 10 amino acids essential to the young rat plus glutamic acid. When leucine, isoleucine, valine, phenylalanine, and methionine were replaced in the diet by the corresponding keto acids plus an equiv. amt. of N as glycine and 0.2% aspartic acid, the animals grew as well as they did on the basal diet.

(Continued on page 30)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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JOHNS-MANVILLE PRODUCTS

Johns-Manville CELITE FILTER AND PRESSING AIDS

SELECTED ABSTRACTS

(Continued from page 28)

The effect of carbohydrate-free and carbohydrate-low diets on the incidence of dental caries in white rats.

SHAW, J. H. *J. Nutrition, 53,* 151-62 (1954).

Two carbohydrate-free rations and a low carbohydrate ration were found under intensive tests to be incapable of producing tooth decay in a highly-caries susceptible strain of rats.

Dental caries in the cotton rat. XIV. Further studies of caries production by natural diets with especial reference to the role of minerals, fat, and the stage of refinement of cereals.

CONSTANT, M. A., SIEVERT, H. W., PHILLIPS, P. H., AND ELVEHJEM, C. A. *J. Nutrition, 53,* 12-27 (1954).

$CaCO_3$, disodium phosphate, basic salt mixts., with and without Ca, and near neutral salt mixts. contg. Ca retarded the development of caries.

Effects of substituting xylose for glucose in a purified diet for pigs.

WISE, M. B., BARRICK, E. R., WISE, G. H., AND OSBORNE, J. C. *J. Animal Sci., 13,* 365-74 (1954).

Two expts. were conducted to compare xylose and glucose as sources of carbohydrate. Growth-performance and balance studies indicated that pigs were able to utilize glucose to a greater degree than xylose. Voluntary activity was decreased, and the color of the hair coat was altered in pigs fed xylose.

Prevention of the cholesterol type of fatty livers in mice by dietary dihydrocholesterol.

BEHER, W. T., AND ANTHONY, W. L. *J. Nutrition, 52,* 519-24 (1954).

Increasing the cholic acid content of a diet contg. cholesterol (I) significantly increased mouse liver cholesterol (II) and steroids, up to a limiting value. Addn. of dihydrocholesterol (III) to diets contg. cholic acid and I significantly decreased II and steroids. Increasing the cholic acid content of a diet contg. const. amts. of III and I significantly decreased II and steroids.

Sequence of histologic changes in skin of dogs in relation to dietary fat.

HANSEN, A. E., SINCLAIR, J. G., AND WIESE, H. F. *J. Nutrition, 52,* 541-54 (1954).

The findings suggest that dietary fat supplies a factor necessary for the maturation of epithelial, sebaceous and sudoriparious cells which, when absent from the diet, results in distinct abnormality in the skin demonstrable both microscopically and grossly. The process is readily reversible and changes in an orderly fashion when fat is added to the diet.

Vitamins in dermatology.

BERESTON, E. S. *J. Clin. Nutrition, 2,* 133-9 (1954).

From this by no means complete review of the uses of vitamins in dermatology, it can be seen that in spite of enthusiastic claims, the indications for vitamin therapy are few in no. Nevertheless, there are certain diseases in which vitamin administration is clearly indicated.

PHARMACOLOGY AND TOXICOLOGY

Effect of tea on gastric secretions and motility.

WIRTS, C. W., REHFUSS, M. E., SNAPE, W. J., AND SWENSON, P. C. *J. Am. Med. Assoc., 155,* 725-9 (1954).

Tea appears to increase the rate of gastric emptying when compared to the effect of an equal amt. of H_2O, when used with a 40% protein, carbohydrate, fat or combined (eggnog) meal. The iced beverages used have a more pronounced effect in this regard than hot. Tea appears to stimulate gastric motility.

Toxicology of surfactants.

BARAIL, L. C. *Soap Chem. Specialties, 30,* 51-3*, June, 1954.

No synthetic detergent has been found to belong to the very high toxicity group. However, quite a few belong to the high toxicity and median toxicity groups. Rarely is there any need for using a product, the toxic and irritation characteristics of which render it hazardous to safe use whether in the home or in industry.

DETERGENTS

Classifying detergents.

KARABINOS, J. V., KAPELLA, G. E., AND BARTELS, C. E. *Soap Chem. Specialties, 30,* 41-3, June, 1954.

A series of six org. qual. tests have been successfully applied to the classification of various types of anionic and nonionic detergents.

ENGINEERING AND PLANT EQUIPMENT

Conveyors and elevators.

STRUBE, H. L. *Chem. Eng., 61,* 195-210, April, 1954.

This complete report describes the features of various types of bulk material handling equipment and provides aids for proper selection of equipment for a given job.

Joint operation of multiunit complexes for minimum cost.

MAYER, K. M. *Ind. Eng. Chem., 46,* 1247-55 (1954).

A method for the calcn. of least-cost production schedules was developed which will enable a management to operate 2 or more production units simultaneously and under all cost conditions, with the assurance that any desired output will be made at min. cost. The methods are completely general in application.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

Experiments with fruited breakfast cereals.

FOX, H. *Food, 23,* 227-9 (1954).

Tests on both ready-to-eat and cooked cereals with fruit added during processing are described. Experimentation done at Food Tech. Dept. of Univ. of Calif.

CHEMICALS IN FOODS

Chemicals in foods.

OSER, B. L. *Food Eng., 26,* 70-2*, June, 1954.

Several F. D. A. rulings and actions on certain coal-tar colors and food additives are discussed.

Chemicals and food.

DODDS, E. C. *Food Sci. Abstr., 26,* 241-6 (1954).

It is recommended that the system of investigation and control be perfected rather than abolish the addn. of chemicals to foods.

FATS AND OILS

Expanding uses of antioxidants.

TAPPEL, A. L. *Food Eng., 26,* 73-5*, June, 1954.

Description of new uses of antioxidants in improving stability and acceptability of many foods.

Antioxidative properties of cacao and their effect on butteroil.

MUELLER, W. S. *J. Dairy Sci., 37,* 754-60 (1954).

The antioxidant properties of cacao shell, cocoa powder, and certain exts. of these products were detd. in butteroil by the use of two accelerated tests, the modified Schaal test and the Swift fat stability test. Detns. were made for peroxide values, color, taste, and odor. This study substantiated previous observations that cacao shell and cacao powder contain a natural antioxidant that is effective in retarding oxidative deterioration of milk fat. The cacao antioxidant also was an inhibitor of the pro-oxidant effect of Cu.

FISH AND SEAFOOD

The preservation of wet fish. Part I.

RIEMAN, H., AND BRAMSNAES, F. *FAO Fisheries Bull., 7,* 49-65 (1954).

Summary of existing knowledge on storage of fish close to freezing temps. Fields of research of most immediate interest are pointed out. 109 references.

FRUIT JUICES AND VEGETABLES

Orange carotenoids: polyoxygen carotenoids of Valencia orange juice.

CURL, L. A., AND BAILEY, G. F. *J. Agr. Food Chem., 2,* 685-90 (1954).

Seventeen different xanthophylls were found in 3 of 6 fractions from a counter-current distribution sepn. All 17 were found to be either xanthophyll epoxides or corresponding furanoxides, which are, in general, less stable than the simpler carotenoids, especially in acid medium.

Ever try to freeze stew?

SMITH, D. V. *New Jersey Agr., 36,* 7-8, May-June, 1954.

The problems encountered when trying to freeze a stew contg. potatoes are discussed. Potatoes soaked in 5% $CaCl_2$ for

(Continued on page 32)

PROTOVANOL C

an AMAZINGLY EFFECTIVE REPLACEMENT FOR COUMARIN . .

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SELECTED ABSTRACTS

(Continued from page 30)

30 min. gave the best results. Taste panel tests showed no detectable flavor.

Wastes from potato starch plants.

AMBROSE, T. W., AND REISER, C. O. *Ind. Eng. Chem., 46,* 1331-4 (1954).

Information on the character of the plant wastes was accumulated and possible processes for the utilization of these wastes were mentioned.

LEGISLATION

Label statements concerning dietary properties of food purporting to be or represented for special dietary uses. Certain foods used as means of regulating intake of sodium in dietary management.

FOOD AND DRUG ADMINISTRATION. *Federal Register, 19,* 3999-4000 (1954).

Changes in label statements.

PRESERVATION

Food irradiation.

PROCTOR, B. E. *Refrig. Res. Foundn., Info. Bull.,* Suppl. 1-7, June 15, 1954.

Irradiation offers more promising use in extending storage life of foods kept under refrigeration than in preserving foods not kept under refrigeration.

SEASONINGS

Dry solubles. Versatile seasoning agents.

HOLHOF, E. I. *Food Eng., 26,* 83-4+, June, 1954.

A description of what dry sol. seasonings are and why they are used. The methods of manuf., handling, and storage are also described.

SUGAR

Sugar types and uses.

QUINLAN, D. *Food Eng., 26,* 85-6, June, 1954.

A listing of the various forms and characteristics of sugar products and the food products with which they should be used.

PACKAGING

Fill control of granular products.

WAY, C. B. *Can. Food Inds., 25,* 31+, June, 1954.

A simple fill control program is briefly outlined and a method of evaluating the pack fill as a whole is laid out.

Plastic films at low temperatures.

FREEMAN, A. J., SHERIDAN, L. W., AND RENFREW, M. M. *Modern Packaging, 27,* 147-51+, June, 1954.

New data on toughness and gas-transfer characteristics of films including Mylar. Tables and graphs of latest work conducted at the General Mills Research Labs. are included.

Mirror-coated acetate foil.

Packaging (Brit.), 36, 47+, June, 1954.

An acetate foil with a brilliant mirror finish. Product is made by Utilex Ltd. and can be obtained in thicknesses of 1-20 thousands of an in., reels from 19-40 in. wide.

PHYSICAL RESEARCH

Viscosity and electroviscous effect of emulsions.

VAN DER WAARDEN, M. *J. Colloid Sci., 9,* 215-22 (1954).

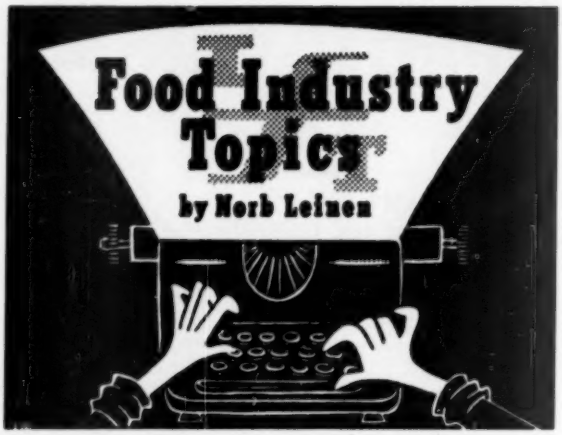
From the viscosities of oil-in-water emulsions of varying particle size and concn. an apparent increase in oil concn. during flow was derived. The particle sizes were calcd. from light-scattering data of these emulsions. Combination of these data makes it possible to calc. an apparent increase in particle diam. during flow in cases where interaction between oil droplets is precluded. This increase seems to be independent of particle size and is ascribed to the elec. charge on the surface of the particles.

PATENTS

Egg drying.

JENSEN, L. B., AND HALE, C. Assignors to Swift & Company. 2,681,286, June 15, 1954.

The method of improving the whipping properties of fermented, dried egg whites which comprises adding to the egg whites a small but perceptible amt. not exceeding about 1.0% by wt. of acetyl-methylcarbinol.



. . . in the public interest

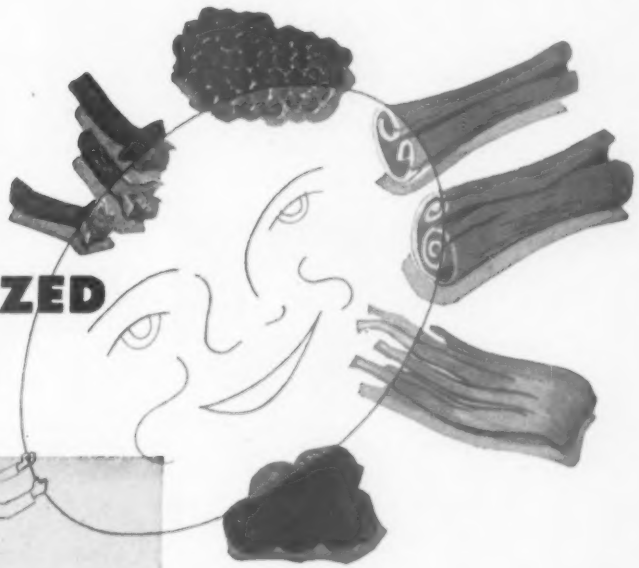
The cause of the devastating explosions in Texas City on April 16 and 17, 1947, was revealed recently in a paper written by Dr. Raymond Hainer, senior chemist, and Dr. Warren C. Lothrop, vice president of Arthur D. Little, Inc., Cambridge, Mass., one of the firms chosen by the U. S. Coast Guard to do research under the guidance of a special National Research Council committee. Fertilizer grade ammonium nitrate (FGAN), the shipboard explosion of which had caused the disaster, was found to merely burn at constant pressure, inasmuch as the compound disassociates into gaseous ammonia and nitric acid, which reaction absorbs heat and limits the temperature rise caused by the fire. If, however, the pressure is high, this controlling reaction is prevented and an explosion can result. It was reasoned that, from the fire within the mass of 40,000 bags of ammonium nitrate in the hold of the *S. S. Grandcamp,* sufficient pressure for the products of decomposition developed locally to produce an explosion that touched off the entire cargo. The scientists also proved that spontaneous combustion at excessive temperature can cause a fire in FGAN, although farmers were assured that under ordinary conditions of good housekeeping and use it will not ignite or explode spontaneously. As a result of this work, new shipping instructions issued by the Coast Guard permit shipment of FGAN anywhere in the world with complete understanding of the hazards involved.

◆ ◆ ◆

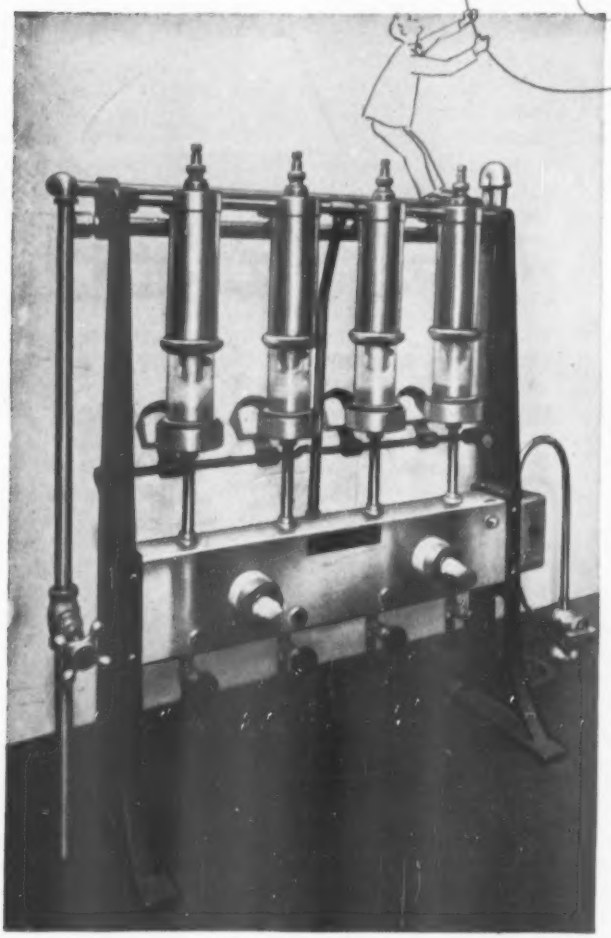
"Egg Solids—The Inside Story," a 16 mm color and sound film has been issued by the Egg Solids Council, 221 N. LaSalle St., Chicago, Ill., to provide industry conventions, schools and colleges, women's clubs, and television stations with the interesting story of egg solids processing from collecting eggs at the farm to drying and packaging. It also shows the many consumer products which use egg solids and compares the baking problems of a Victorian homemaker with today's modern baking conveniences. The Egg Solids Council, which recently celebrated its second anniversary, comprises producers of egg solids as well as companies in allied fields.

(Continued on page 34)

How Griffith's Extraction Process Assures Better-Flavored Products



PEPPEROYAL AND SOLUBLIZED SEASONINGS



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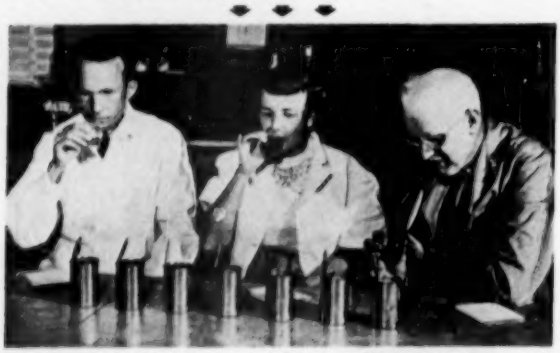
FOOD INDUSTRY TOPICS

(Continued from page 32)

A specially designed exhibit entitled "Take Away That Bitter Taste" has just been presented to the Smithsonian Institution's Division of Medicine and Public Health by Dodge & Olcott, Inc., New York City flavor house. Occupying a place in the medical gallery, the exhibit traces the evolution of flavoring medicine from some of the earliest known records to the modern laboratory where synthetics mark the farthest rise of this particular science. The exhibit also displays samples of present-day pharmaceuticals where flavor products known to ancient civilizations are still basically applied.



This panel of food tasters, at American Can Company's research laboratories at Maywood, Ill., is evaluating the taste and odor of canned tomato juice to which an antibiotic substance (subtilin) has been added as an aid to preservation. The company, as part of its long-range research activities to find new and more efficient methods of canning food products, is currently experimenting with various antibiotics as possible substitutes for conventional heat sterilization. While no antibiotic has yet been discovered that fully meets the requirements of the canning industry, the firm is hopeful that eventually one may be found that will be helpful in preserving at least some canned products.

A report on the Standard Specifications for Containers and Pallets recommended by the Petroleum Packaging Committee of Packaging Institute is now available at $1.00 a copy from Packaging Institute, 342 Madison Ave., New York 17, N. Y. Known as Report No. 1 of the Petroleum Packaging Committee, it represents the recommendations of the principal users of steel drums and motor oil and grease cans after three years of intensive study. One recommendation has been adopted by American Standards Association as an American Standard. It is planned that the others shall ultimately follow.

The economic well-being of employees is inseparable from that of management and full understanding of this fact is vital to the strength of the nation, stated Mr. Emile F. du Pont in an address to the 27th annual Maine State Safety Conference in September. The outstanding improvement in industrial safety is an example of what can be accomplished through cooperation of management and workers, he said. At the same time, he reported, a recent survey indicated that while most employees feel they can depend on management to make working conditions as safe as possible, only a minority believe management is interested in their economic welfare. Even where management and employees disagree over how the rewards of production should be shared, he continued, it should be obvious that greater production would provide larger shares for all concerned. This, he stated, is where understanding is needed in industry, and this is where management has neglected its obligation to spread information on how our business system operates, and how the economic welfare of employees is inseparable from the economic welfare of management and owners.

. . . *things new under the sun*

A new system of explosion-proof Condulets, consisting of a light source transmitter and a photoelectric tube receiver, now enables automation techniques to be employed at hazardous industrial or transportation areas. Just introduced by Crouse-Hinds Co., Wolf and 7th North St., Syracuse, N. Y., the system automatically activates or turns off lights, starts or stops motors, totals assembly line output, or controls a number of other electrical or electronic devices. The appearance or absence of light as detected through a lens in the receiver's photoelectric tube causes a relay to open or close the electrical circuit.

Automatic cycling control for processing equipment is offered by Eclipse Fuel Engineering Co., Rockford, Ill., through the firm's "DO" (diaphragm operated) solenoid valves. Long operating life is insured by the simplicity of construction of the valve. There are only two moving parts—the solenoid plunger and the synthetic rubber diaphragm. The valves, which can operate on line pressures as high as 150 psi, are pilot operated, with line pressure furnishing the activating force. Power is required only to lift the solenoid plunger. Servicing may be performed without removal from the line.

Tenney Engineering, Inc., 1090 Springfield Rd., Union, N. J., announces the first **self-contained table-model low-temperature test chamber.** Measuring only 29½" high x 57" long x 30½" wide, and weighing but 450 lbs., this table model produces temperatures to minus 100° F. and will dissipate 1000 B.t.u. per hour at minus 80° F. It also produces high temperatures to 212° F. To produce the extremely low temperatures required, and at the same time include all operating equipment within the small over-all dimensions, the cascade system of refrigeration is used. The company reports this system also costs less to purchase and operate, and is simpler to maintain. Automatic controls stop and start refrigeration and heating equipment to maintain set temperatures within ±2°.

Food, plastic, sulfite pulp, and chemical plants may find extensive use for a **new line of lower-priced stainless steel Rockwell-Nordstrom lubricated plug valves** introduced by the Meter and Valve Division of Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa. Featuring chrome-plated plugs, the new valves are suitable for most services in which the more expensive stellite-coated Rockwell-Nordstrom stainless steel valves have previously been used. The chrome

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Magic Crystals

Now End Flavor Fading In Your Processed Foods

With Zest,® 99+% Pure Monosodium Glutamate, Food Processors Make Foods More Flavorful Than Ever!

AMERICA'S LEADING FOOD PROCESSORS USE THESE STALEY PRODUCTS

Staley's 99+% Pure Monosodium Glutamate—pure, free-flowing crystals that intensify natural food flavors.

Corn Syrup—Sweetose Brand-high conversion sweetener for firmer texture, better flavor.

Corn Oil—A vegetable oil of highest quality for cooking and food processing.

Lecithin—An established emulsifier and antioxidant for the Food Industry.

No need to let heat, pressure and other processing conditions rob food of taste appeal. Zest magnifies the natural flavors without adding any flavor, color or aroma of its own. Whether your products are frozen, dehydrated or canned, Zest brings out all their natural goodness—puts them first on the consumer's shopping list.

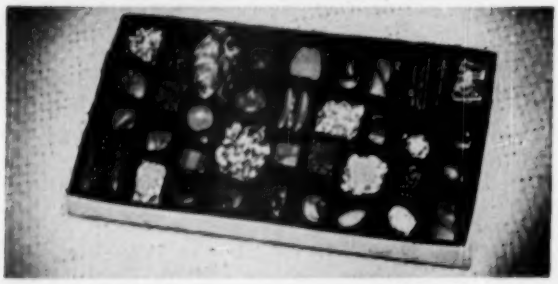
A. E. STALEY MFG. CO., *Decatur, Ill.*

Zest — Staley's

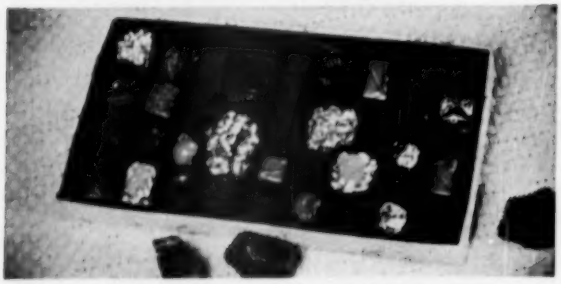
Industries Served by Staley Products

BAKING • CONFECTIONERY • ICE CREAM • FOOD PROCESSING

for flavors



that bring



them back

for more!

GIVAUDAN FLAVORS have helped many confectioners and ice cream manufacturers build new business and increase their repeat sales on the basis of truly distinctive taste appeal.

Givaudan is a *primary* source of supply—the world's largest producer of aromatics. Our flavor experts have developed a complete line of basic flavor materials, natural fruit and imitation flavors for every type of confectionery, ice cream, and other food products. They will gladly help you select the right flavor for your products . . . or cooperate with you in developing an individual flavor to meet your special needs.

Givaudan Flavors Inc.

330 West 42nd Street, New York 36, N. Y.

Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Seattle • Los Angeles • Toronto

FOOD INDUSTRY TOPICS

(Continued from page 34)

plating backed by stainless steel offers double protection against scoring, galling, and other effects of corrosion. New valves are offered in the same sizes and types available in Rockwell's higher priced line.

◆ ◆ ◆

A new general purpose industrial detergent, Planisol, is being supplied to the fatty oils, meat packing, and heat processing industries by the Votator Division of The Girdler Co., 224 E. Broadway, Louisville 1, Ky. It rapidly emulsifies all types of oil and leaves a chemically clean surface. Although highly alkaline, it contains no caustic soda or potash and can safely and easily be handled by plant personnel. It is nontoxic, will not burn the skin, and is non-inflammable. Planisol is reported also to have excellent bactericidal and deodorant qualities.

◆ ◆ ◆

The new Model 517 "Alphatron" Vacuum Gauge, operating on A.C. current, features six ranges permitting the measurement of pressures from 1000 to 0.0001 mm. Hg. on a linear scale. Like other "Alphatron" vacuum gauges offered by the Naresco Equipment Corp., equipment sales subsidiary of National Research Corp., the Model 517 utilizes a sealed radium source; this emits alpha particles and produces ionized gas molecules which are collected on a plate to produce a current indicating directly the measured pressure. The gauge cannot be damaged by exposure to atmospheric pressure because the ion source operates at room temperature and at zero potential. The Model 517 is priced at $425, ready for immediate installation. A catalog sheet giving complete details is available from the company, located at 160 Charlemont St., Newton Highlands 61, Mass. Also offered with the catalog sheet is a reprint of a recently published paper entitled "A Survey of Gauges for Measurement of Low Absolute Gas Pressures."

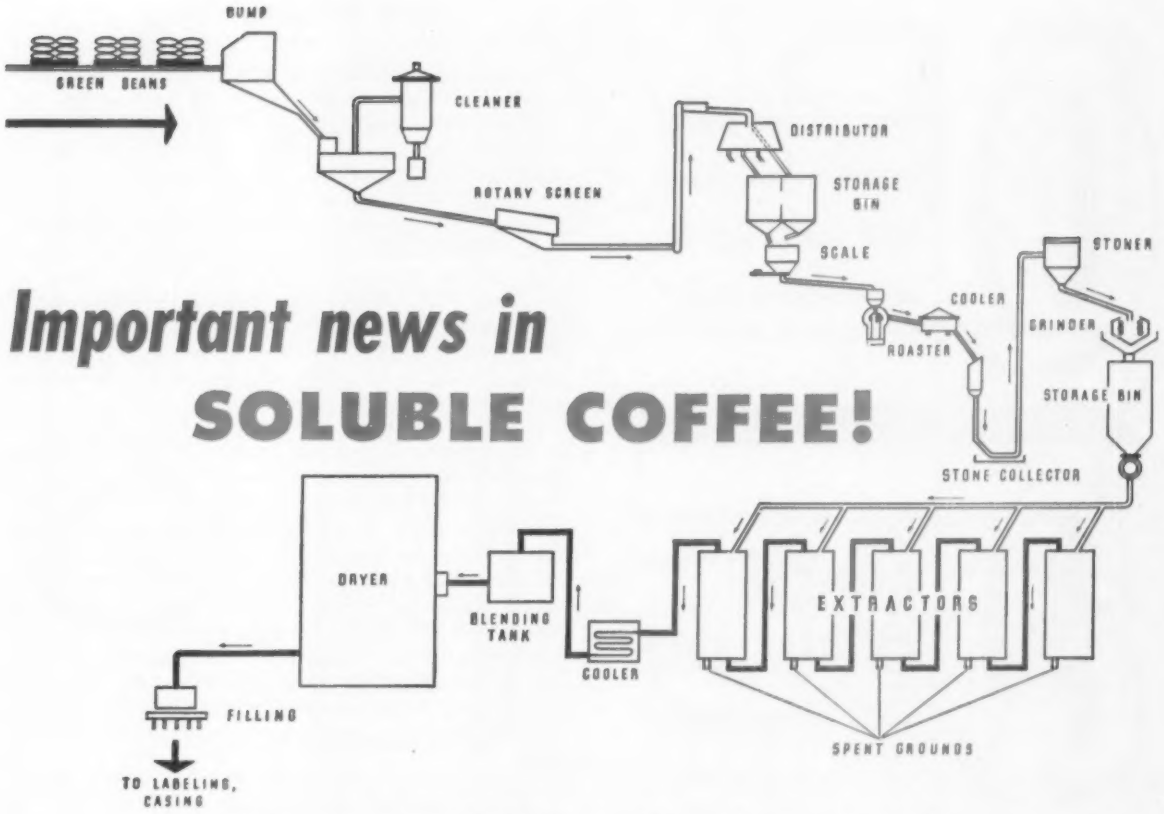
◆ ◆ ◆

A laboratory version of their highly successful Ultrafast Dissolver that can also be used for small scale production work has been developed by the Cowles Co., Inc., Cayuga 1, N. Y. The new laboratory model, only 30" high, utilizes any one of several patented Cowles impellers. It will give manufacturers in the chemical, plastics, and allied industries their first opportunity to experiment with the patented Cowles high speed machinery on a small scale basis. The standard Cowles Ultrafast Dissolver has been used to cut solution, dispersion, and suspension times by as much as 97% in some applications.

◆ ◆ ◆

The Ohaus Scale Corp., 1050 Commerce Ave., Union, N. J., announces availability of a **new balance** known as the Cent-O-Gram Model C. G. 311. This balance has a sensitivity of one centigram, a capacity of 311 grams, and fulfills a need in bridging the gap between the analytical balance and the conventional

(Continued on page 38)



Important news in SOLUBLE COFFEE!

This new soluble coffee system gives you everything you need to blend your own!

Now you can get *your* share of the sky-rocketing sales in the "instant" coffee business!

Although it comes to you as a "packaged process," this Pfaudler system can easily be controlled to produce the flavor you want—maintaining the desirable flavor characteristics of your present blend of roasted coffee.

Right from the raw bean down through the steps of cleaning, roasting, extracting, drying and packaging, this new Pfaudler process gives you fingertip control. The extraction and drying of the roasted bean to produce soluble coffee is continuously regulated to produce a good, uniform product.

You can rely on the results because this process has been engineered by The Pfaudler Co.—we've been serving the food industries for 70 years. Pfaudler high-speed filling machines, percolators, processing vats, storage tanks and other food processing equipment are helping hundreds of food processors increase production and get a higher quality product. Pfaudler's standard designs and easy-to-clean alloy or glassed steel construction make this possible.

Get into the profitable soluble coffee business. You don't have to work out your own process, or track down equipment for it. Pfaudler will design, procure and fabricate everything you need. A complete plant layout will be furnished. If you desire, we can also handle erection and furnish start-up service. Write for the full story on soluble coffee.

THE PFAUDLER CO. Pfaudler **ROCHESTER 3, N. Y.**

Q. How can you retard rancidity and extend shelf life of high-fat, low-moisture foods?

A. Use **DIAMOND CRYSTAL SALT** with antioxidant!

Potato chips, prepared mixes, nuts, and many other products that are high in fat and low in moisture are often spoiled by rancidity and the development of oxidative "off" flavors. These factors play an important role in reducing the shelf life and profit margin of many food products.

Diamond Crystal Salt with **ANTIOXIDANT** will help to avoid these problems!

Diamond Crystal Salt with **ANTIOXIDANT** is as simple to use as plain salt. If sodium chloride is used in your processing, this antioxidant medium will fit into your operation without the added expense of extra equipment or labor.

Diamond Crystal Salt with **ANTIOXIDANT** is economical, too! For example, the extra cost involved in salting potato chips is only about 7¢ per 100 lbs. of chips! This is a small cost to minimize "returned goods," and to assure the factory-fresh flavor of your product.

The effectiveness, ease of use, and economy of this new salt will more than justify its test in your operation. Samples are available upon request. Send for yours today!

Write to

TECHNICAL SERVICE DEPT. J
DIAMOND CRYSTAL SALT CO.
ST. CLAIR, MICHIGAN

FOOD INDUSTRY TOPICS

(Continued from page 36)

trip balance. The price of $29.50 includes two 100-gram attachment weights needed to increase the capacity to 311 grams. Graduated beams, pan bows, and weighing pan, as well as other exposed parts, are of stainless steel. Write for free literature.

◆ ◆ ◆

"Duo-Set" timers for controlling on-off cycling of two independently adjusted load circuits in machine and process control are described and illustrated in Bulletin N-80 offered by Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Philadelphia 44, Pa. (Dept. "N"). Timers are listed with nine dial ranges from 30 seconds to four hours, and minimum settings as low as ½ second.

◆ ◆ ◆

The "Utilitank," a completely **new line of vertical glassed steel storage tanks** in capacities from 1000 to 5000 gallons, has been introduced by The Pfaudler Co., Rochester 3, N. Y. The line was designed to meet the need for an inexpensive storage tank for neutral products like paint, pigment, wax, anti-freeze, liquid sugar, syrups — products which could be stored in plain steel if it were not for the possibility of product contamination by plain steel or the difficulty of cleaning plain steel. With certain modifications, Utilitanks can be used for bulk storage of dry products. Detailed information is contained in the company's Bulletin 916.

◆ ◆

Data sheets and prices on the firm's complete list of organic sulfur compounds are available from Evans Chemetics, Inc., 250 E. 43rd St., New York 17, N. Y. Products covered include: thiovanic acid, thiophenol, thiomalic acid, evanacid 3CS, salts of thioglycolic acid, 2-ethylhexyl mercaptan, thiovanol, phenylmercaptoacetic acid, p-cholorothiophenol, 2-mercaptoethylamine hydrochloride.

◆ ◆ ◆

Lydon Brothers, Inc., 85 Zabriskie St., Hackensack, N. J., is offering an eight-page folder illustrating and presenting brief specifications on its line of ovens, dryers, and conditioners for industrial processing.

. . . *the literary corner*

A technical bulletin on the use of Indulin, a pine wood lignin, for removal and recovery of proteins and enzymes has just been issued by the Polychemicals Division of West Virginia Pulp and Paper Co., Charleston, S. C. General discussion is followed by case histories on the use of Indulin with sugar beet press water, mold protease, malt diastase, thin stillage, grain sirup, beverages, and wool protein. A copy of Technical Bulletin No. 105 may be obtained by writing the company. .

◆ ◆ ◆

"Packaging News," a complete service for buyers of packaging materials and equipment, is a new monthly publication published by Creative Journals, Ltd., 9 Grosvenor St., London W. 1, England, for the purpose of reporting, concisely and promptly, significant developments in all branches of packaging. The journal will be sent free of charge to 7,000 directors

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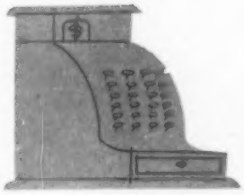

sheffield milk proteins can ring up more sales for you

Sheffield milk proteins are today helping to bring increased sales and profits to many enterprising food processors. These milk proteins serve as excellent dispersing, stabilizing and water binding agents in many foods—ice cream mixes, bread, doughnuts, processed meats, infant food and others.

By supplementing your food products with high quality milk proteins, you get these important, profitable benefits:

- *Improved appearance*
- *Improved texture*
- *Increased shelf-life*

Sheffield guards the high nutritional quality of its milk proteins through complete control of the process from farm fresh milk to finished product. Sheffield milk proteins are fat free, pleasing to taste, variable in protein content, white in color and many are sodium free.

Milk proteins are only one of many products of Sheffield research, all directed toward supplying food processors with superior ingredients. Our research department will gladly work with your laboratories to develop new products or improve old ones. For detailed information, write: *Sheffield Chemical Company, Food Division, Norwich, N. Y. — or to our branch office at 1267 Sixth Avenue, New York 19, N. Y.*

SHEFFIELD

MILK PROTEIN EDIBLE POWDER
HIGH NITROGEN CASEIN
SODIUM CASEINATE POWDER
CALCIUM CASEINATE POWDER

LEADS THE FIELD IN MILK PROTEINS

A DIVISION OF NATIONAL DAIRY PRODUCTS CORPORATION

FOOD INDUSTRY TOPICS

(Continued from page 38)

and executives responsible for their companies' packaging, and at a small annual subscription rate to those interested who do not qualify from the standpoint of packaging responsibilities.

◆ ◆ ◆

"Perfumatics" (perfume aromatics) for perfumery and industrial use are detailed in a special catalog issued by F. Ritter & Co., P. O. Box 39696, Los Angeles 39, Calif. The flavor firm also welcomes inquiries for new syntheses and special developments in rare organic preparations.

◆ ◆ ◆

The September issue of *Pak-Facts*, Vol. 1, No. 4, published by Transparent Package Co., 3520 S. Morgan St., Chicago 9, Ill., is devoted to two interesting articles. The first, "Look at Your Labels," stresses ways and means of establishing character in a label. The second article, "Hot Dogs and Rugby," contains an account of food buying trends in South Africa as related by two visiting businessmen from that country. According to the account, the swing to self-service merchandising in South Africa is slow because (1) the customers refuse to carry any packages, large or small, and hence all packages must be delivered; and (2) segregation of races is so stringent that duplicate counters are set up in markets to service each race. Self-service would necessitate maintaining a much more elaborate store with many more duplicate counter displays in order to handle all of the merchandise.

◆ ◆ ◆

For the convenience of those interested in improving or extending the uses of peanuts, scientists of the U. S. Dept. of Agriculture have packed into an abstract bibliography of 92 of their publications on peanuts a variety of facts they turned up in eleven years of utilization research. The information relates to composition, properties, reactions, technology, storage, and almost every phase of the processing of peanuts—kernels, oil, meal, protein, hulls, and peanut butter—much of it potentially applicable by industry and agriculture. The booklet, AIC-369, entitled, "SRRL Publications on Peanuts, 1942-1953: Facts from Research on Utilization," is obtainable by writing the Southern Regional Research Laboratory, 2100 Robert E. Lee Blvd., New Orleans, La.

◆ ◆ ◆

"Don't Expect Miracles" titles an intriguing article in the Fall 1954 issue of *The Chemical Digest*, Vol. 20, No. 3, publication of Foster D. Snell, Inc., 29 W. Fifteenth St., New York 11, N. Y. Among precepts to follow, according to the article, to insure worthless analytical results are these: (1) collect a sample that is too small; (2) in the event you feel the chemist's time is not fully occupied, write under the analyses desired the word "Complete"; (3) to apply the coup de grace, fail to provide the chemist with sufficient information when requesting the analysis. Let him guess! The original article by B. E. Saltzman, from which the Snell material is extracted, appeared in *Occupational Health*.

. . . *meeting hall and conference room*

A Symposium on Chemical Aspects of Flavor and Odor Perception, part of the program of the Division of Agriculture and Food Chemistry of the American Chemical Society at the ACS' 126 National Meeting in New York City in September, was headed by Dr. Dean Foster, IFT member and director of laboratories of the United States Testing Co., Hoboken, N. J. He was assisted by Dr. L. R. Elder, also a member of the IFT, of General Foods Central Laboratories, Hoboken. In his remarks, Dr. Foster saw the combined efforts of the several scientists as the only way in which objective measures of consumer reactions to foods can be made. In this combined effort, he stated, the contribution of the chemist must become dominant rather than secondary, as it is now. For example, he pointed out, the psychologists can indicate what groups of compounds all taste sweet, but the chemists most logically can define the common property that makes each of them taste sweet.

◆ ◆ ◆

"There is overwhelming evidence that we are witnessing the birth of a great sucrochemical industry," Dr. Henry B. Hass, president of Sugar Research Foundation, Inc., told the annual meeting of the **U. S. Beet Sugar Assn.,** held at Mackinac Island, Mich., in August. The term "sucrochemistry," Dr. Hass explained, was coined to cover the branch of the chemical industry which is based upon sugar and its by-products. One project currently being sponsored by Sugar Research Foundation may someday have far-reaching effects on the broad problem of feeding the world, according to Dr. Hass. That is . . . the search for an organism which can start with molasses and ammonia and produce a protein rich in lysine and

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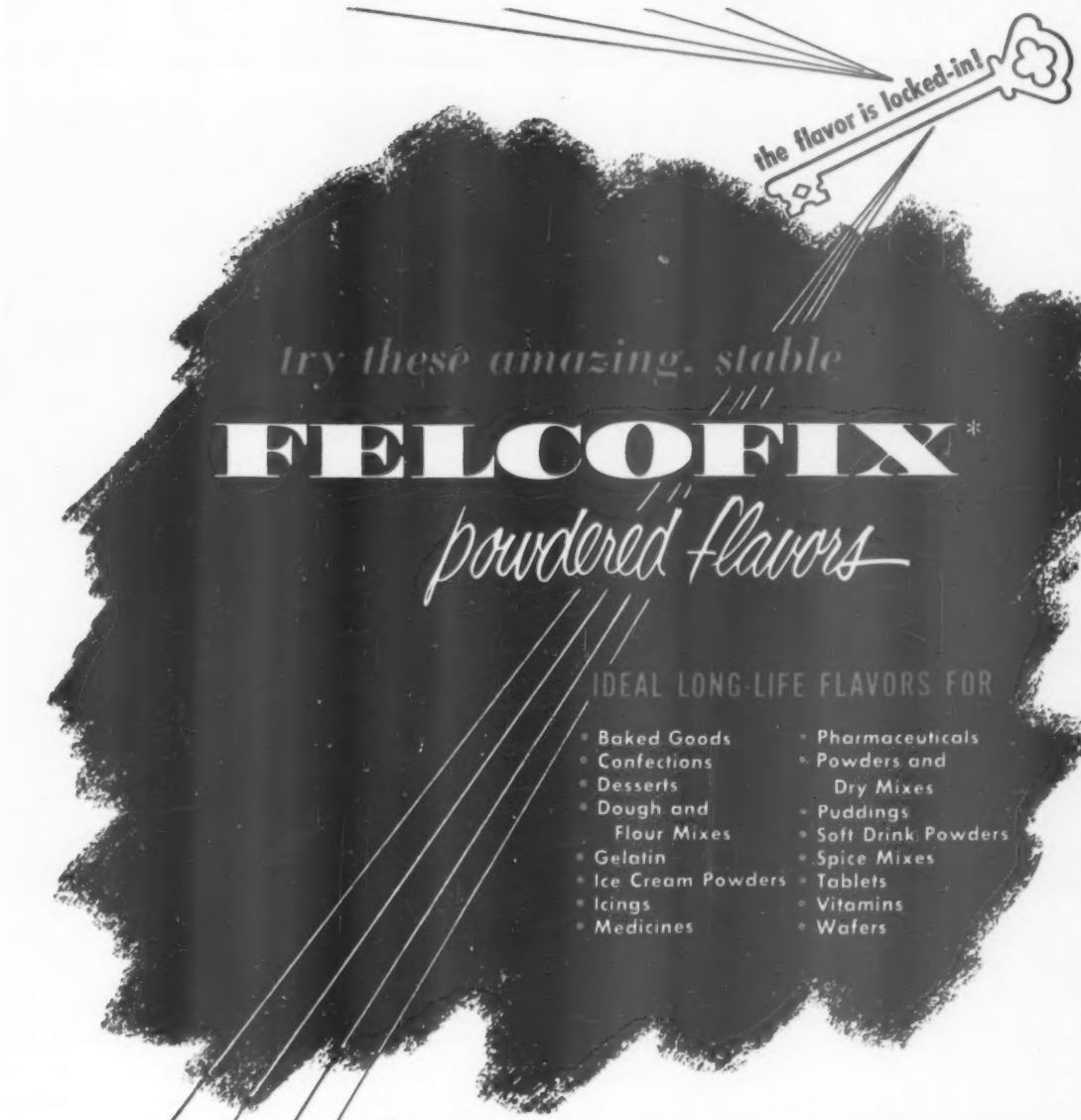
FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1954	
November 3-5	Association of Food Industry Sanitarians, Hotel Statler, Los Angeles, California
November 15-18	International Soft Drink Industry Exposition, Convention Hall, Philadelphia, Pennsylvania
November 20	National Food Survey of Great Britain, Middlesex Hospital, London, England
December 12-15	American Institute of Chemical Engineers, New York, New York
December 27-30	American Association for the Advancement of Science, University of California, Berkeley, California
1955	
February 21-24	International Food Show, New York, N. Y.
March 7-10	American Society of Bakery Engineers, Edgewater Beach Hotel, Chicago, Illinois
March 13-17	Frozen Food Industry Convention, Hotel Hilton, Chicago, Illinois
March 13-17	National Assocition of Frozen Food Packers, Hotel Hilton, Chicago, Illinois
March 29-30	National Conference of Interstate Milk Shipments, Hotel Peabody, Memphis, Tennessee
March 29-April 7	The 127th National Meeting of the American Chemical Society, Cincinnati, Ohio
April 30-May 2	American Academy of Applied Nutrition, Pasadena, California
June 12-16,	**Institute of Food Technologists, Hotel Deshler, Columbus, Ohio**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)



Felton's complete line of FELCOFIX powdered flavors offers you the best answer to the problem of permanently flavoring all kinds of dry, semi-dry or powdered products . . . completely eliminating that old shelf-life bugaboo!

These outstanding flavors are supplied as dry, perfectly homogeneous powders that remain fresh, true and delicious even when used in mixtures containing acids, sugars and other reactive ingredients.

Their concentration and lasting power are equally amazing, and result in economies that are important to your profits.

It will pay you to try our FELCOFIX flavors without delay!

Write now for Sample of these amazing new **FELCOFIX** locked-in **FLAVORS**

FLAVORS • ESSENTIAL OILS • AROMATICS

FELTON CHEMICAL COMPANY, INC.
599 Johnson Ave., Brooklyn 37, N. Y.

*FELCOFIX is a trade mark of Felton Chemical Co., Inc.

PLANTS: BROOKLYN, N. Y. • LOS ANGELES, CAL. • MONTREAL, QUE. • VERSAILLES (S & O) FRANCE
SALES OFFICES: ATLANTA • BOSTON • CHICAGO • CLEVELAND • PHILADELPHIA • ST. LOUIS • TORONTO

FOOD INDUSTRY TOPICS

(Continued from page 40)

tryptophan, two essential amino acids which so far have never been produced by any cheap artificial method.

◆ ◆ ◆

The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo., sends word concerning the forthcoming **Refrigeration Workshop Week.** On Jan. 10-13, 1955, the Foundation and the NARW will hold a training conference for warehouse personnel at the Edgewater Beach Hotel, Chicago. On Jan. 13-15, overlapping the training conference, the annual meeting of the Scientific Advisory Council of the Foundation will take place in the same hotel. To these sessions the USDA Cold Storage Research Advisory Committee will be invited, so that its members can join in the consideration of research on the refrigeration of commodities in advance of the formal meeting of the Committee in Washington, D. C., February 14-16, 1955. Members of the newly formed Industry Advisory Council of the Foundation are also urged to attend and participate in these Council sessions.

◆ ◆ ◆

Polak's Frutal Works, Inc., manufacturers of essential oils, perfume, and flavoring raw materials, celebrated its **40th anniversary** on August 21. Appropriate ceremonies were held in Amersfoort, Holland, where the company was founded by Mr. Jac. Polak and his brother, the late Henri Polak. From its origin in a small building, the company has developed into a world-wide organization with its main seat now established in Middletown, N. Y., and associated companies in Holland, England, Belgium, France, and Germany.

◆ ◆ ◆

Insecticides do not cause any diseases or increased susceptibility to disease in either man or animals, Dr. David E. Price, Assistant Surgeon General of the U. S. Public Health Service, told the **National Agricultural Chemicals Association** at its 21st annual meeting at Spring Lake, N. J., in September. He stated that this opinion is based on the results of extensive research, particularly by the U. S. Public Health Service. In an election of new officers, Mr. W. W. Allen, manager, Agricultural Chemicals Sales, The Dow Chemical Co., was elected president; Mr. Fred W. Hatch, vice president, Agricultural Chemicals Division, Shell Chemical Corp., was elected vice president; and Mr. Lea S. Hitchner, Washington, D. C., was re-elected executive secretary-treasurer of the Association.

. . . *building up and branching out*

Sale of the American Paper Goods Co., Kensington, Conn., to Continental Can Company has been approved by the directors of the two companies, it

F. RITTER

presents

COUMASIN

(without coumarin)

A substitute for coumarin at equal strength. $3.00 per lb.

Also its companion, TONKASYN AMORPHOUS, twice the strength of coumarin at $6.00 per lb.

F. RITTER & CO.

4001 Goodwin Ave. Los Angeles 39, Calif.

Branches in Principal Cities

To preserve flavor
and nutrition in

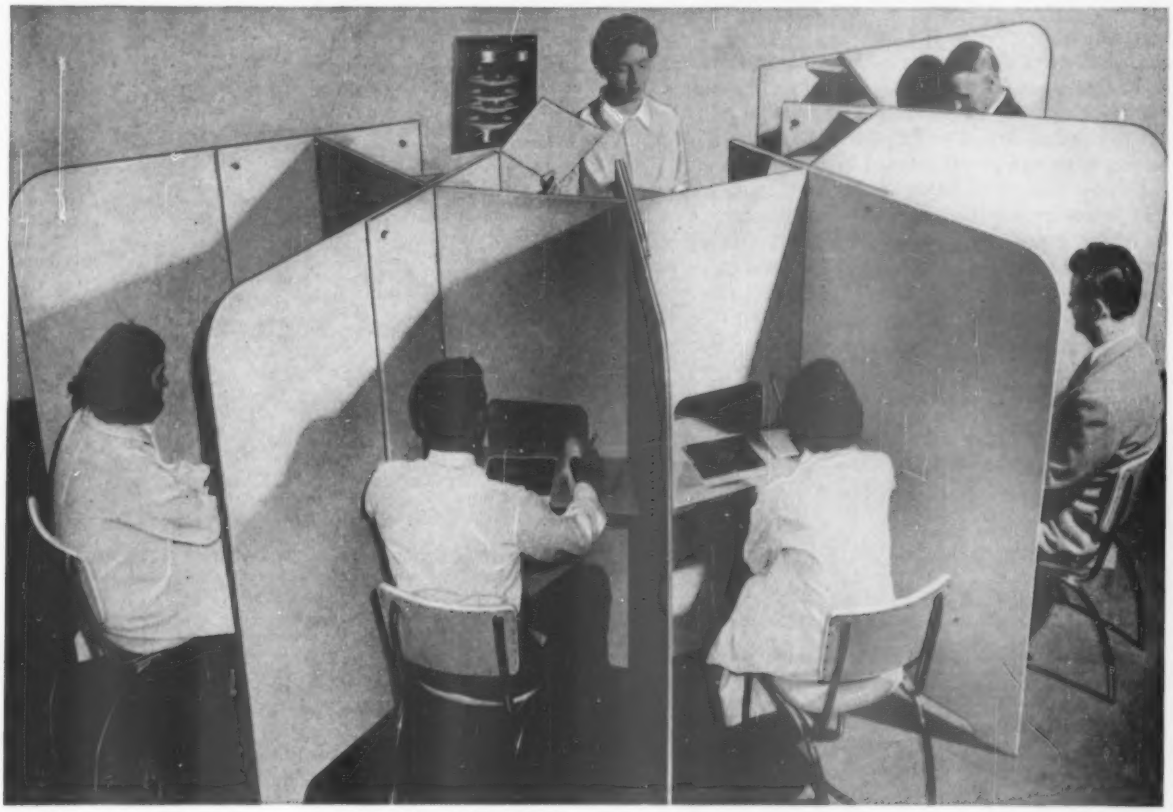
Dog Foods

use **Tenox** EASTMAN FOOD-GRADE ANTIOXIDANTS

For complete information about the effectiveness of Tenox in combating rancidity in dog foods, write to

EASTMAN CHEMICAL PRODUCTS, INC.
Subsidiary of Eastman Kodak Company
KINGSPORT, TENNESSEE

BIG NEWS about FISH STICKS!



New taste test shows that MSG can double consumer preference!

Here's important news for everyone who makes, sells or buys frozen fish sticks.

Famous United States Testing Company, Inc., reports that you can *double* consumer preference for your fish sticks by simply adding MSG at the Huron-recommended level of .18%. This conclusion is based on a scientific taste test (Psychometric) of treated and untreated fish sticks.

What the test revealed

67% of the taste panel preferred fish sticks with MSG added at the .18% level, to 33% who chose the untreated samples. What's more, 67% also preferred MSG at the .18% level, while only 33% went along with the sticks treated with .05 MSG (the "usual" level). This finding completely confirms the .18% level long advocated by Huron's Technical Service.

What the test means to you

Whether you process, sell or buy frozen fish sticks, this test means you can actually "build in" your product a taste appeal that's preferred by twice as many consumers. That's a tremendous competitive advantage which is bound to put your product on top. It spells more sales . . . more profits in today's booming frozen fish sticks market. We'll be glad to send you a free copy of the United States Testing Company, Inc., report.

Don't forget — Huron MSG can heighten the flavor of most frozen foods — meats, poultry and vegetables as well as fish. Write or phone our Technical Service today for all the facts on this easy way to make your brand the one people prefer. The Huron Milling Co., 9 Park Place, New York 7, N.Y.

8.4.7

Huron **MSG**

Made by the American pioneers in protein derivatives

FACTORIES: Harbor Beach, Michigan

SALES OFFICES: 161 E. Grand Avenue, Chicago 11 • 13 E. Eighth Street, Cincinnati 2 • 383 Brannan Street, San Francisco 7

FOOD INDUSTRY TOPICS

(Continued from page 42)

was announced recently by Gen. Lucius D. Clay, chairman of the board of Continental, and Mr. Albert S. Redway, president of American Paper Goods. Confirmation of the transaction is subject to ratification by the latter firm's stockholders. American Paper Goods, with two plants located in Kensington and Chicago, manufactures paper cups, envelopes, and bags. "It is not anticipated that there will be any changes in plant locations," Gen. Clay said. "Continental will operate this business as a supplement to its paper container division."

◆ ◆ ◆

During a recent visit to the United States for the purpose of increasing their line of beauty preparations and to purchase their additional requirements of cosmetic colors from H. Kohnstamm & Co., Inc., Mr. Harry Ushiyama, president, Hollywood Cosmetic Co., Inc., of Japan and Hollywood, and Mrs. May Ushiyama who operates an exclusive beauty salon in Japan were photographed in Kohnstamm's New York City offices at 89 Park Pl. From left: Henry Masuda; Mr. Si Blovitt, Kohnstamm export manager; Mr. Ushiyama; Mrs. Ushiyama; Mr. Louis J. Woolf, president of H. Kohnstamm & Co., Inc.; and Miss Nery Mendoza, Kohnstamm export department.

◆ ◆ ◆

Minneapolis-Honeywell Regulator Company has purchased the assets of Heiland Research Corporation of Denver, manufacturer of precision scientific instruments and high-quality photographic flash equipment, Mr. Paul B. Wishart, Honeywell president, announced recently. The 20-year-old Denver firm will be operated as a new Honeywell division, with the Heiland part of the name retained. The new division will continue to operate from its Denver plant and offices, with the present production, administrative, and sales personnel.

◆ ◆ ◆

Mr. Frank Greenwall, president of National Starch Products, Inc., 270 Madison Ave., New York City, and Mr. Richard Moss, chairman of the board of Clinton Foods, Inc., in a joint statement recently confirmed that discussions are taking place looking to a merger of the Corn Processing Division of Clinton Foods with National Starch Products.

. . . *the human element*

Mr. E. R. Durrer, president of The Givaudan Corporation and its associate companies, Givaudan-Delawanna, Inc., Givaudan Flavors, Inc., and Sindar Corp., returned recently from a three-month visit to the Givaudan factories in Switzerland and France. Discussing European business conditions, he reported that business in Switzerland and in Europe in general is being conducted on a continuously high level. The fears and pains of recession which were felt in the United States, he remarked, did not seem to have had any serious or disturbing repercussions on the Continent, and business sentiment has continuously remained optimistic.

◆ ◆ ◆

Mr. Hammer

The promotion of **Mr. Natt K. Hammer** to the position of assistant manager of the industrial sales department of the A. E. Staley Mfg. Co., Decatur, Ill., corn and soybean processor, has been announced by Mr. R. L. Nagle, industrial sales manager. Mr. Hammer, who has been manager of the firm's Chicago branch office since 1952, succeeds **Mr. Ray E. Harroun** who has been appointed manager of the Staley branch office in San Francisco. The latter office has been expanded to cover both the industrial and package products of the Staley corn division. **Mr. Ralph R. Dombroski,** acting manager of the San Francisco office since 1953, has been named as manager of the Chicago office.

◆ ◆ ◆

Mr. John O. Bouma, formerly associated with Carmen & Company and the Nevens Company, both of Minneapolis, has been appointed to the national sales staff of The Huron Milling Co., 9 Park Pl., New York City, it was announced by Mr. B. F. Bowman, vice president, sales and product development. Mr. Bouma,

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FLAVOR MEASUREMENTS

of

MERORY FULL AROMATIC TRUE FRUIT FLAVOR

(PATENT PENDING)

10 FOLD BLACK RASPBERRY

MF 954

(Flavor test made in 100 parts of water)

1. Threshold of **PERCEPTION** . . . . . : **0.175%**
   Color: Faint

2. Threshold of **IDENTIFICATION** . . . . . : **0.21 %**
   Color: Distinct

3. Threshold of **COMMERCIAL FLAVOR AVERAGE** . . . . . : **0.25 %**
   Color: Sufficient

4. Threshold of **FULL AROMATIC FLAVOR** . . . . . : **0.375%**
   Color: Brilliant

5. **FLAVOR PROFILE:**

   One gallon of 10 FOLD FULL AROMATIC BLACK RASPBERRY equals in aroma, flavor strength, natural color, solids, and acid to 10 gallons of juice expressed from 108 pounds of freshly picked BLACK RASPBERRIES (1954 crop yield : 10.8 lbs. fruit per 1 gallon).

   No other fruit, flavoring, or coloring but RASPBERRY is used.

Alcohol content . . . . . approx. : **18 %**

One gallon of 10 FOLD FULL AROMATIC BLACK RASPBERRY MF. 954 replaces 27 pounds Dehydrated BLACK RASPBERRIES.

Complete recovery of flavor and color from the fruit by our Full Aromatic manufacturing process yields more than the normal flavor strength of expressed juice. Our 10 fold Full Aromatic BLACK RASPBERRY MF. 954 permits stretching of the flavor strength up to 15 fold of restored juice and thus additional savings of about 50 per cent are possible.

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FOOD INDUSTRY TOPICS

whose appointment furthers Huron's program to strengthen distribution and service for its MSG (monosodium glutamate) and HVP (hydrolyzed vegetable protein), will service a considerable midwestern territory under the direction of Mr. J. P. Pfaff, manager of the firm's Mid-West Division office in Chicago.

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Two new technologists have joined the Central Laboratories of General Foods, Hoboken, N. J., it was announced by Mr. Harvey Murer, general manager of the unit. **Dr. John A. Rikert** has joined the research unit as associate technologist in product development. He holds a B.S. degree from the University of Massachusetts, and M.S. and Ph.D. degrees from Rutgers University. **Miss Edith B. Bleisch** has been appointed junior technologist in the food acceptance area. She is a 1954 graduate of the University of Rhode Island.

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At its General Meeting held in the Manhattan Center in New York City on September 13, the American Chemical Society announced that **Dr. Hans Schinz** of the Federal Institute of Technology, Zurich, Switzerland, had been chosen as the 1955 recipient of the ACS-sponsored Fritzsche Award. This $1000 cash and gold medal award, donated annually by Fritzsche Brothers, Inc., New York essential oil firm, for outstanding achievement in the field of essential oils and related chemicals, will be presented to Dr. Schinz at the Society's spring meeting. Dr. Schinz, a native of Switzerland, has gained world repute for his extensive work on the analysis and elucidation of the components of essential oils and their synthesis.

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Dr. Robert F. Light, an IFT member and former chairman of the New York section, has been appointed technical director of the Special Products Division of Standard Brands, Inc., located at the company's headquarters, 595 Madison Ave., New York 22, N. Y. Dr. Light was formerly assistant director of research at The Fleischmann Laboratories of Standard Brands.

IFT member **Alfred E. Leighton,** consulting food chemist and candy technologist and author of *A Text Book on Candy Making,* has undertaken the writing of "An American Log" as a monthly contribution to *Confectionery Production,* leading British trade magazine of the confectionery industry.

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Mr. John H. MacMillan, Jr., president of Cargill, Inc., Minneapolis, announced that IFT member **Dr. Arthur R. Baldwin,** recently associated with the Chemical Division of Corn Products Refining Co., Argo, Ill., had been appointed as director of research of the Cargill organization. Dr. Baldwin is well known in research, and in 1951 won the coveted Norman Award in Hamburg, Germany. He joined Corn Products Refining Company in 1944, and has directed that firm's research development in the fields of fats, oils, and food products.

EMPLOYMENT NOTICES

POSITION WANTED: Administrative, research or teaching. Ph.D. biochemistry, nutrition; M.S. microbiology; B.S. pharmacy, pharmacology. Experience: 4 yrs. professor; 8 yrs. industry. REPLY BOX 359, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Young man for extensive technical supervisory training for industrial management career by leading Northwest Brewery. West Coast applicants with degree in chemical engineering, chemistry or Food Technology. Under 30 yrs. of age. Send resumé academic and practical experience, also salary required and photograph. REPLY BOX 358, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist. For research and development work by food processor in Chicago. Good opportunity for advancement in rapidly expanding, well-established concern. Require S.B. degree, preferably under 30. Send resumé to BOX 360, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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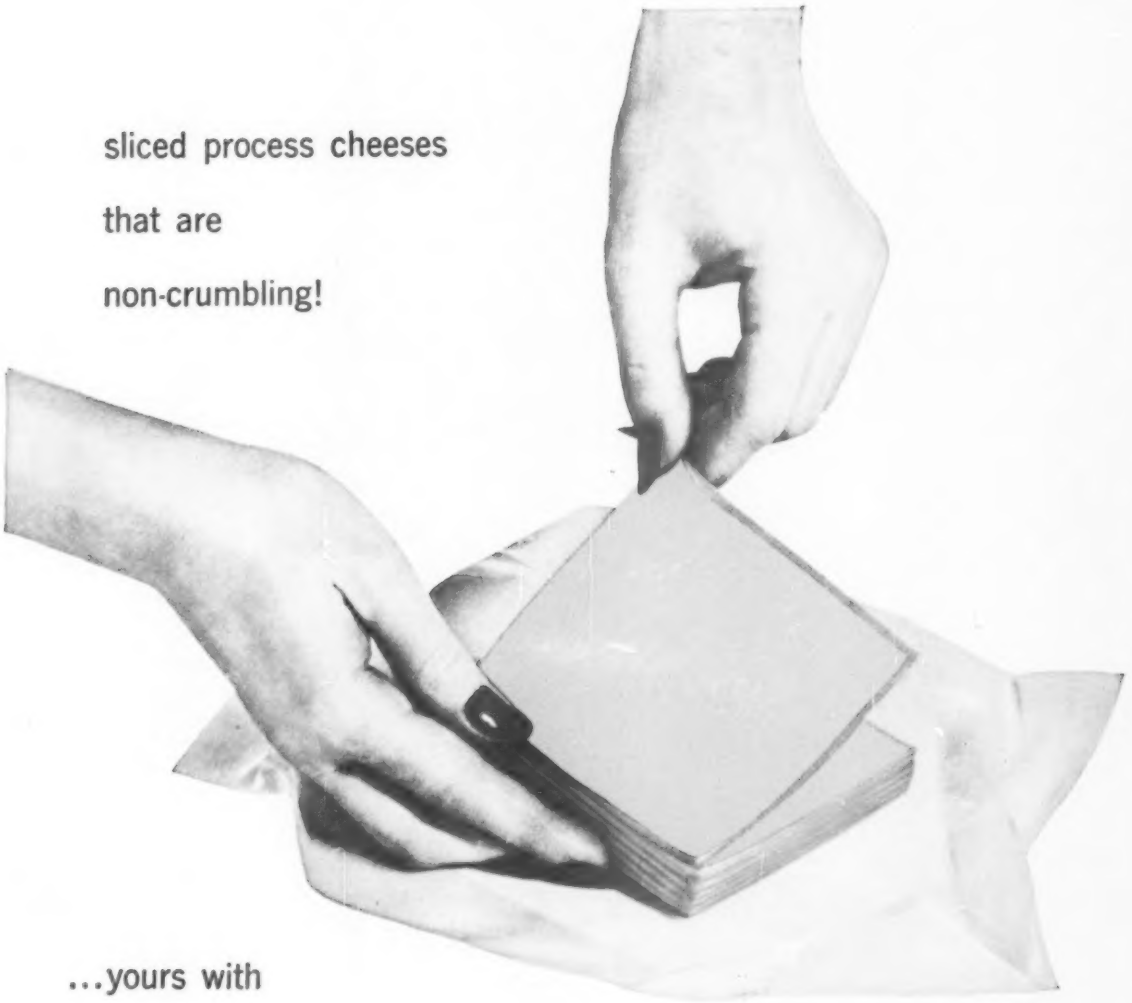

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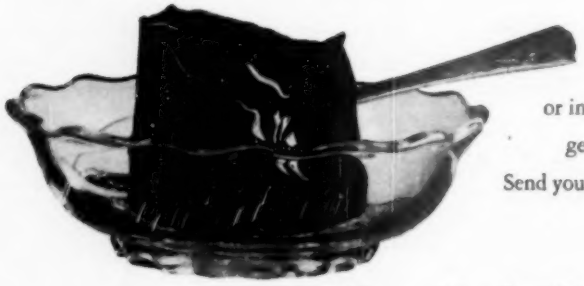

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